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THE SEMI-CENTENNIAL OF THE DEARBORN OBSERVATORY.

PHILIP FOX.

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ADDRESS BY PROFESSOR FOREST RAY MOULTON.

THE PROGRESS OF MATHEMATICAL ASTRONOMY.

You can imagine with what satisfaction I come before you here to explain in a few minutes the advances that have been made during the past fifty years in a subject nearly two hundred years old, and which more than a century ago was so advanced that it took a lifetime to master its complexities. However hopeless the task may be which I face, I can at least tell you about some of the things that are involved in these investigations.

Professor Hale has told you how the doctrine of evolution dominates all modern thought. In order that any doctrine shall be sound and applicable throughout the millions and probably hundreds of millions of years of celestial evolution, at least its fundamental laws must be correct. The one central law on which all discussion of celestial evolution is based is the law of gravitation, discovered by Newton over two hundred years ago. It was at once applied to explaining the motions of the Moon and the planets, and the results were satisfactory. The question then arose as to whether the law is exact enough to account for all the motions of these bodies for indefinite intervals of time. This question has been very prominent in the thought of mathematicians for more than a hundred years. In attempting its answer, difficulties were encountered of a character so serious that I cannot tell you about them fully, and I must confess that not all of them have been entirely overcome.

In spite of the difficulties, the law of gravitation, as it was expressed in 1688, by Newton, is correct to a degree of approximation that has not been attained in any other branch of science. The method by means of which its truth has been so exactly established can be illustrated by a simpler problem. One way to measure the force of gravity at the surface of the Earth is to determine the time in which a pendulum of given length, let us say a seconds pendulum, will vibrate, because the time of vibration depends on the force of gravity. We can measure with a certain degree of precision the time of one vibration and find the force of gravity with corresponding accuracy. But suppose the pendulum makes a hundred swings; the error in measuring the whole interval will be no greater than in the case of a single vibration, and hence gravity will be determined one hundred times as accurately. Since in a day there are 86,400 seconds, in a day the accuracy is increased 86,400 fold. In ten days the precision in the determination of gravity is 864,000 times that obtained from a single vibration. It is evident that accuracy is a result of the accumulation of the effects of the quantity which it is desired to measure. Something like this occurs in testing the law of gravitation by the motions of the heavenly bodies. We cannot verify it with any considerable accuracy by observations of one day or one year. But from observations extending over two centuries, we repeat that the law of gravitation is established with a degree of precision which is not approached in the case of any other scientific law.

Now, what has been accomplished in the last fifty years? What unexplained phenomena of fifty years ago have been shown to be consequences of the law of gravitation? Half a century ago there were only two outstanding questions, one a small peculiarity in the motion of the Moon, which only modern powerful instruments could reveal, and the other an equally slight peculiarity in the motion of Mercury. These irregularities did not seem to follow from the law of gravitation and astronomers were at a loss to account for them. It was not known whether these discrepancies between theory and observation were due to imperfections in the mathematical processes or to an inexactness in the law of gravitation. The foremost mathematicians of the world from the time of Newton to the present have attempted to answer this question. The difficulties it presented were most formidable and the work required was appalling. For example, Delaunay spent twenty years computing the series for representing the motion of the Moon; his finished work, which was published about fifty years ago, was so extensive that several hundred quarto pages were required for the final answer alone. The work of Delaunay closed an epoch, and though monumental, was yet incomplete from a logical point of view.

In 1877, George W. Hill, of Washington, in a brilliant series of papers, inaugurated a new epoch in the Lunar Theory. From Newton to Hill's immediate predecessors there had been much in common in the methods employed. Hill broke loose from the processes which earlier astronomers had used and with rare originality marked out entirely new paths. Before his work on the theory of the motion of the Moon was completed, he was compelled to turn his attention to the theory of the mutual perturbations of Jupiter and Saturn. Fortunately, the young English mathematician, E. W. Brown, appreciated the importance of Hill's methods and carried them out probably about the same as Hill would have done if his attention had not been diverted. The completed Lunar Theory is a monumental piece of work, giving hundreds of agreements between theory and observation, and furnishing no hint that the law of gravitation is not a sufficiently exact expression of the forces between celestial bodies to be used safely for the long intervals of time involved in the problems of evolution in Astronomy. There are, however, very slight peculiarities in the motion of the Moon which do not follow from theory, but these outstanding discrepancies can be explained in a number of possible ways; and, in spite of the perfection of the work of Hill and Brown, there are still points in which its logic is not complete.

Following the work of Hill came that of the great Frenchman, Poincaré, whose brilliant genius has dazzled the whole world. With excessive modesty he confessed that his work on the problem of three bodies owed its inspiration to Hill. Hill was highly original, but Poincaré added to originality and the highest order of genius a perfect command of all the resources of modern mathematics. Unquestionably, his work will stand out for centuries like that of Newton and Laplace. One of the principal problems which he attacked was that of the exactness of the law of gravitation, and whether, under it, the solar system in which we live is stable; that is, whether the Earth will continue indefinitely to revolve around the Sun at approximately its present distance, or whether it will gradually wind in on the Sun and be consumed, or wind out and wander off into the night of space. He did not completely answer this question, but we hope that fifty years from now, at the hundredth anniversary of the Dearborn Observatory, it will have been settled. But we do know now that the Earth will continue to revolve around the Sun at approximately its present distance for immense ages.

One other great discovery whose applications, at least, have been made in the last half century I wish to mention. A little more than half a century ago the great physical principle of the conservation of energy was announced. In the discussion of the evolution of the

universe it is as important as that of the law of gravitation. Professor Hale spoke of the possible evolution of a nebula into a star. In its contraction it developed heat energy in conformity with the principle of the conservation of energy. Helmholtz first applied this principle to contracting suns about sixty years ago, and his work was followed by that of Kelvin, Lane, and Ritter. This work shows us that if our own Sun has no other important source of heat, it cannot have supplied the Earth with heat for more than about 20,000,000 years. On the same basis, the Sun will not give the Earth heat more than about 10,000,000 years in the future.

These figures were derived on the basis that the Sun has no other important sources of heat than that produced by its own contraction. But physicists and chemists have recently found that some atoms break up into their constituent parts, and that in the process an enormous amount of energy is liberated. Possibly the sub-atomic energies are important sources for maintaining the heat of the stars. At any rate, most geologists believe, on the basis of geological evidence, that the Earth is many tens of millions of years, if not hundreds of millions, old, and astrophysicists are generally willing to admit that the life of a star is many times 20,000,000 of years. And if this is true, we may reasonably infer that the Earth will exist and be suitable for the abode of life for tens of millions of years in the future.

So we see that mathematical astronomy for the last fifty years has not been devoted to applying the law of gravitation to current celestial phenomena, for that had been done with almost complete success a half century earlier, but to a rigorous testing of the fundamental laws and principles on the basis of which we shall unfold and come to understand the evolution of the universe from infinity to infinity.

Address by Professor George E. Hale.

Some Reflections on the Progress of Astrophysics.

The great national edition of the works of Galileo, published by the Italian Government under the skilled and devoted editorship of Professor Favaro, contains a page of unique interest in the archives of astronomy. Reproduced in facsimile from Galileo's note-book, the hasty sketches and rapid notes made during his first telescopic observations of Jupiter lie before us. Copernicus had already published his great work on the revolutions of the heavenly bodies, and Galileo, with a mind singularly free from the medieval prejudices of the day, had accepted the heliocentric view, and had become its chief exponent. But the true conception of Jupiter's system of satellites dawned slowly,

and in the few notes made from night to night we can trace its development in Galileo's mind. First regarded as stars, whose changing configurations must result from the motion of Jupiter, the satellites were gradually perceived to belong to a wonderful system revolving about Jupiter as the planets revolve about the Sun. This splendid illustration of the views of Copernicus marked the downfall of the Ptolemaic system and the beginning of modern astronomy.

Of this new era, which arose from the invention of the telescope, it is not within my province to speak. But we must realize how the astrophysics of the last half century is deeply rooted in a more remote past. When Galileo discovered spots on the Sun he opened to investigation the problems of solar physics. In the same century Newton decomposed sunlight into its primary colors, though he failed to detect the dark lines of the solar spectrum. These were first seen by Wollaston and accurately mapped by Fraunhofer in the year of Waterloo. But although Fraunhofer discovered similar lines in the spectra of certain stars, and even detected the coincidence of the double yellow line of sodium in a flame with the double dark line which he called D in the solar spectrum, the significance of these observations was not perceived until 1859.

It is a remarkable fact that firm foundations for the study of both organic and inorganic evolution were laid in this same year. *The Origin of Species*, presenting a vast mass of evidence in support of the theory that new species originate by natural selection, raised the biological world out of the systematism of Linnaeus into the stimulating atmosphere of the Darwinian period. At the same moment the study of the evolution of the Sun and stars was made possible by Kirchoff's law of selective absorption and his identification of the dark lines of the solar spectrum with the lines of the chemical elements in the flame and spark. It became as easy to determine the chemical composition of the solar atmosphere as to analyse a common substance by the ordinary processes of the chemist. Sodium, iron, calcium, hydrogen, in fact nearly all terrestrial elements, were found in the Sun and soon afterward in stars. If a new star blazed out in the Milky Way, its chemical constituents were seen to be of the very kind most familiar to us on the Earth. Thus a marvelous unity, embracing the most remote objects of the universe, was at length perceived. And the instrument that revealed it furnished also the means of tracing the life histories of the stars.

Secchi, Rutherfurd, Huggins, and Draper were the pioneers in this new field. The diverse spectra of the stars were at once recognized as indications of physical development. Huggins' discovery of the gaseous nature of certain nebulae was taken to point to a source of material

from which stars might be formed. And thus was set on foot that splendid campaign, rendered possible by the effective use of the objective prism and the modern slit spectrograph, powerfully supplemented by the photographic plate, which has carried us well on the way toward a perception of the course of stellar evolution.

I cannot attempt to trace the tactics, or even the broader elements of strategy, in this great attack on the celestial hosts. Nor may I pause to show how one unit in the stellar ranks, placed as an outpost at the center of the solar system, has been subjected to the varied assault to which his proximity exposes him. The time at my command may be better devoted to a brief survey of some of the larger results achieved and a glance at the means which have made them possible.

So few are the principal types into which the stars may be resolved that Fraunhofer himself detected most of them. Disregarding certain special groups, and confining our attention to the more pronounced marks of distinction, we find that more than a hundred thousand spectra photographed at Harvard belong to the following classes; white stars, in which the lines of helium are conspicuous; stars, also white, in which hydrogen plays the leading role, while traces of the metals begin to appear; yellowish stars, like the Sun, in which the hydrogen lines, less conspicuous than before, are accompanied by thousands of lines due to metallic vapors; and orange or red stars, in which the still fainter hydrogen and stronger metallic lines are accompanied by bands characteristic of titanium oxide. These classes stand in an unbroken sequence, passing over by slow and barely perceptible changes from one to another, and marking out a line of development in which some single variable must undeniably play the dominant part. The differences in the spectra, indicated by the greater or lesser prominence of one or another element, cannot mean fundamental differences in chemical composition. This might be proved in several ways, but is perhaps most clearly illustrated by the recently discovered fact that certain variable stars, of the Cepheid class, undergo a regular variation in spectral type in the space of a few hours, showing at the same time corresponding fluctuations in brightness and in temperature. Again, we know that the spectrum of a sunspot, a cooler region on the Sun, closely resembles that of a red star, which is essentially a cooler Sun.

Temperature, then, is the main source of the observed differences in stellar spectra. The white helium stars attain temperatures of perhaps 20,000° C, the white hydrogen stars may exceed 10,000°, the yellowish stars like our Sun measure about 6,000°, while the red stars range from 2,000° to 3000°, thus falling within the limits attained by our electric arcs and furnaces. With these and certain laboratory devices

we may test this temperature hypothesis, and prove its general validity beyond any reasonable doubt.

Thus in the gradations and sequence of their spectrum lines, in color differences corresponding with the shift of the maximum brightness in the spectrum toward the red with lowering temperature, and in other respects no less remarkable, the stars fall into an ordered series. Only recently has it been shown by Kapteyn, Campbell, and Boss that the speeds with which the stars are moving through space also vary in the same sequence; a condition so unexpected and so fundamental that it taxes existing means of interpretation.

At this point astronomy and astrophysics have joined hands in pushing forward the study of stellar evolution. The stars vary enormously in mass, in density, and in surface brightness, and if we are to discuss intelligently the differences in their spectra we must reduce them as nearly as may be to a common basis. A long step in this direction has been taken by classifying stars, not merely on the indications of their apparent brightness, but in terms of their actual brightness—the brightness they would have if they were all brought to the same distance from the Earth. To do this we must know their exact parallaxes, few of which have been determined until recently with the necessary precision. Fortunately a strong group of astronomers, including the director of the Dearborn Observatory, is coöperating most effectively in the photographic measurement of stellar distances. The number of parallaxes already determined has sufficed to yield some remarkable conclusions, when coupled by Hertzsprung and Russell with the results of spectroscopic and photometric investigations.

The first of these is that the white stars greatly exceed the Sun in actual brightness, while the very faint stars are invariably red. Moreover, there appear to be two great classes of stars: those of extreme brightness, which have been called *giants* and those of lesser brightness called *dwarfs*, of which our Sun is a typical example. In the case of the red stars these classes are sharply separated into two groups, between which there seem to be no stars of intermediate brightness.

We may not pursue in their interesting details the conclusions and speculations to which this new conception of stellar classification has given rise. Some of them require the support of further observations before they can be finally accepted, but recent work strongly confirms the view that a point of inflection is likely to enter the time-honored path of stellar evolution. Lockyer, on other grounds, suggested long ago that the curve of development should have both ascending and descending branches, and advanced spectroscopic evidence in support of his conclusion. But his reasoning and results differ in many respects from Russell's.

According to Russell, the red giant stars of great diameter, low density, and low temperature, represent the early stage of sidereal life. Contraction following radiation of heat would give rise to denser and hotter stars, culminating in the intensely hot white stars of the helium class. Further contraction, attended by a reduction of temperature, would result in the dense dwarf stars, which occupy the declining slope of the curve of stellar development.

Whatever our predilections, we must welcome most cordially the new light which has been thrown on our central problem, even if we cling to the classic idea that the white stars are young while the red stars, irrespective of their absolute brightness, represent the period of decline. This older and more widely accepted view has the advantage of affording an unbroken transition from nebular to stellar spectra, which is lacking if we begin our sequence with Russell's red giants. Yet Adams has recently shown that for spectroscopic reasons the red stars should be divided into two groups and the progress of research may soon be expected to provide a reliable means of distinguishing between the old and new views.

Time fails me to show how the spectroscope has extended Bessel's "astronomy of the invisible" into a larger realm, and revealed a new department of double star astronomy, now connected without essential discontinuity with the classic field to which the Dearborn telescope, in the hands of Burnham, Hough, and Fox, has made so many contributions. Nor may I enter the great domain of star-streaming, which belongs primarily to astronomy, though the last wide extension of its boundaries has come from the work of the spectroscope. The old barriers between the physical and the structural problems have broken down, and the old and new astronomy are working together in the closest harmony. Adams has just demonstrated, for example, a simple means of determining a star's distance from a knowledge of its apparent brightness and the ratios of the intensities of certain lines in its spectrum. Founded upon the indispensable parallax measures, which will ultimately extend both its range and its precision, the new method should prove a powerful ally in the further study of both the structure and the evolution of stellar systems.

Turning now to the instrumental side, we observe great changes in the observatory equipment during the last half-century. Telescopes have grown in size and in perfection, while their indispensable auxiliary, the photographic plate, has increased their efficiency a hundred-fold. The spectroscope, no longer the simple aid of the chemical laboratory, has taken its rightful place beside the telescope as an instrument of the most diversified possibilities and of the widest usefulness. No longer limited to the determination of chemical composition of flames

and suns, it tells us in no uncertain tones of the motions, temperatures, pressures, magnetic properties, life history, and even the distances of the heavenly bodies. As a result of its growth and refinement the qualitative period of spectroscopy, once a reproach, has given place to an era of measurements which cannot be surpassed for precision in the entire range of science. Brought into closer contact with the physicist and chemist, the astrophysicist has profited without limit by their marvelous progress, and adapted their devices to his special needs. Thus the observatory has received from the laboratory scores of auxiliaries and methods, which have led its investigations into unimagined fields. The bolometer and radiometer, the perfected thermopile and the radiomicrometer, have given us precise measure of the solar radiation and detected its fluctuations, determined the heat of stars beyond the vision of the naked eye, and mapped the vast region of the infra-red spectrum where neither eye nor sensitive plate is of any avail. Selenium and photo-electric cells have proved stars to be variable which were formerly supposed to shine with unchanging light. The recognition of the electron and the rise of modern physics have been reflected in the work of the observatory. The phenomenon of Zeeman, showing the remarkable resolution of spectrum lines under the influence of a magnetic field, is now known to have been seen—though not interpreted—by the solar physicist long before it was detected in the laboratory. The relationship of hydrogen and helium, the effect of an electric field on radiation, and even the principle of relativity are applied or tested in the observatory while yet a novelty in the laboratory or the study of the mathematician. Thus by the use of many new agencies, the astrophysics of yesterday has become the new and broader subject of to-day.

But it is neither in multiplied resources nor in the construction of larger telescopes that we perceive the most significant advance of the half-century. The greatest difference between the present and the past lies in the broadened outlook of the investigator. No longer groping in the dark, or confining his attention to some minute specialty pursued without reference to a larger view, he has widened his horizon and entered into harmonious coöperation with others in his field. Thus the capacity of any single instrument has been multiplied twice, first by the use of the photographic plate or other auxiliary method, and again by the coördination of effort which does away with useless duplication. I have heard the great geologist Suess, a man of the widest interests and richest imagination, describe a certain astronomer as "one of those who busy themselves with those *vermin* of the skies—minor planets and comets." He did not mean that asteroids and comets, which have played such an important part in the larger prob-

lems of our solar system, are not worthy of study. What he objected to was the haphazard way in which they are sometimes observed. It is worth while to record, even without purpose, without reason, and without hope, the position of a chance asteroid or a passing comet. But it is far better to mix intelligence with industry, to plan observations in harmony with some central idea, to coöperate with others in pursuit of some large end. Thus each record may be greatly enhanced in value, and given a better chance of holding a permanent place in the archives of research.

Such is the change which has come over the spirit of the observatory. The accumulation of data is no longer pursued blindly, but is based upon an intelligent plan. Such vast problems as the structure of the universe or the evolution of the stars are now attacked in so sane a manner that progress has multiplied by leaps and bounds. And this is because of a freer and better use of the scientific imagination, acting under the inspiration which we owe in no small measure to Lyell and to Darwin and to others of their time. The theory of evolution is no longer bounded by the limits of the nebular hypothesis or the principle of natural selection. Rising out of these great conceptions, it has expanded into a vast and sweeping vision which embraces all nature. From the whirling electrons in the minute solar system of the atom to the globular star clusters, the spiral nebulae, and the great star streams of the sidereal world is now but a step. Without break of continuity, we study the nature of the electron and the composition of nebulae, the constitution of the atom and the formation of the stars, the organization of complex matter and the evolution of the Earth. We watch with Lyell and Suess, and others of our own day, the development of the Earth's face and the ebb and flow of molten and of aqueous tides. Deep below the Cambrian rocks, embedded in those great sedimentary deposits which filtered during slow millions of years through the depths of prehistoric seas, we find the first signs of life. We isolate the unit of the biologist, and as we marvel at the complexity of the cell as contrasted with the electron, we admire the patience and perseverance which has brought order out of chaos in the intricate mazes of organic existence. We watch the rise of strange life forms, their transformations and effacements, the long intervals of stagnation and repose, the renewed appearance of life in other aspects, graceful and grotesque, gigantic and inconceivably minute. Surveying with Darwin the wide extent of the dead and living world, we perceive the play of a single principle in thousands of diverse organic forms, and see it restore the continuity of that evolutional progress which is more easily traced among the simpler elements of inorganic nature. We observe the modern biologist, applying the experimental method and producing in

his laboratory the variations and mutations which have occurred so often in the history of terrestrial life. We follow the prolific researches of the anthropologist, see him restore the missing links, and trace the marvelous advance which has developed man out of the low intelligence of the anthropoid world. Finally, we see the crude efforts of the first artist endeavoring to express his conceptions, the gathering together of peoples, and the rise of the earliest civilizations. And as we survey the long process of evolution, in its unbroken manifestation from electron to star, from Earth to man, we feel the impulse which has taught us no longer to be content with the limited view point of the specialist, but in whatever we do, howsoever restricted our field, to look out toward the widest expanses of nature and profit in our researches by the clarifying and inspiring example which has been set for us by the leaders of modern thought. Let me close with the words of the great geologist Suess* one of these leaders now unhappily lost to us:

"What a memorable half century we have lived through! During this time, under the influence of increasing knowledge of nature, all human conceptions of the Earth have changed. It is remarkable, however, to see how often the single inquirer, bent upon the object of his quest, fails to comprehend the broader aspects of a problem by whose details he is fettered, just as the stone-cutter clinging to a facade, cannot see the splendor of the structure on which he himself is engaged. And yet there is a special charm in geological studies precisely on account of the extraordinary range of accommodation that is demanded of the eye, of the same eye which now examines the disintegration of quartz in a thin slide under the microscope, now sweeps over snowy mountain peaks, over dark precipitous cliffs and verdant vales, and with commanding glance reads their structure in the features of the landscape. But not less is the demand on the adjusting powers of the mind. From the most subtle conclusions derived from an ingenious experiment the geologist must be able to lift the mental eye over hill and valley into the most distant parts of the universe. There the glowing spectra of nebulæ teach him that even now the great processes of world making are not yet ended. With the aid of instruments he can daily witness the greatest eruptions of superheated gases emanating from the body of our Sun. Photography spreads before him the pictures of the desolate crater-fields of the Moon.

"Returning to his Earth he now perceives that the sum total of life's phenomena not only forms a single phenomenon, but that it is also

* Spoken at the closing banquet of the Ninth International Geological Congress, Vienna, August 27, 1903. See Schuchert, American Geologist, Vol. 33, January 1904.

limited by space and time. It occurs to him now that the stone which his hammer strikes is but the nearest lying piece of the planet, that the history of this stone is a fragment of the history of the planet, and that the history of the planet itself is only a very small part of the history of the great wonderful and ever changing Cosmos.

"His heart then thrills; he feels called as a co-laborer on the most sublime problems in which feeble, mortal beings can take part. Then, too, he sees that the fundamental lines of structure coursing over the Earth's surface have nothing to do with the political lines separating the nations. The vastness of the problem itself makes the concord of civilized nations natural, and they remain separated only through their emulation, all filled with the idea that mankind in general will most highly esteem that nation which is in the position to offer the most and the best of noble example, of new truth and of ideal worth."

To-day, in the midst of the great war, what a melancholy interest attaches to these last lines! Yet they express a lofty ideal, toward which we may hope that the world will continue to grope its way, even though final attainment must lie far in the future.

DARK NEBULAE.

RUSSELL SULLIVAN.

On a fine summer night if one looks at the sky below the bright star Deneb in the constellation Cygnus he will notice a dark spot which interrupts the surrounding brilliance of the Milky Way. This is the northern Coal Sack which the older astronomers regarded as an opening in the Milky Way through which one can look out into the darkness beyond the stars. About the same distance north and east of Deneb is another spot (described by A. and W. Maunder as about the diameter of the full moon) much darker than the surrounding sky. A dark, narrow lane issues from it and runs across the Milky Way, suggesting a flask with a long neck.

In the southern hemisphere a still more conspicuous patch of darkness is surrounded on all sides by the Milky Way, which in these latitudes is exceptionally bright and suggests the approach of dawn when on the horizon. It is about half as large as the bowl of the Big Dipper and never escapes the notice of the most casual observer. Early explorers called it the Coal Sack. It is treated in the folk-lore of Australia and Peru. In the early part of the seventeenth century

Josephus Acosta said that he had seen spots in the sky in Peru. "These spots," he wrote, "are in colour and form like unto the Eclips of the Moone, and are like unto it in blackness and darkness."

According to Allen, the tribes of the Amazon know a dark spot near Orion and call it the "Peixie Boi." There is a dark spot in the great nebula of Orion often called the Fish Mouth. It is darker than the surrounding sky and partly covered by luminous matter. Close by the nebula is a dark, bean-shaped object partly obscuring the nebulous matter near it. It appears to advantage on the Yerkes and Lowell photographs. There are other dark objects in Ophiuchus and Scorpio which are also visible to the naked eye.

The Herschels both noticed dark spots in the sky, but it has remained for Wolf, and especially Barnard, to photograph them. Doubtless some of these spots can be explained as patches of sky devoid of stars, but in view of the evidence it is more likely that the majority are true areas of dark nebulosity. Barnard's photographs taken with a portrait lens and wide field of view, show dark vacancies winding in and out among the stars and nebulae of the Milky Way, some of which can even be followed as faint projections on the surrounding darkness. Faint stars often appear in the vacancies, but these are most likely between us and the dark regions. Hinks says that when the dark body is due to gas, only the luminous nebulosity is darkened; when it is due to dust clouds, both lucid nebulae and stars are blotted out, and if we apply this criterion we must assume that these stars are shining through masses of gas. Slipher has spectrographically traced dark, stationary calcium clouds in front of some of the stars in Scorpio, and recent investigations by Daniel show them to exist between us and certain stars in Orion. Many curious figures and letters are traced in the bright back-ground by the smaller and less diffused spots, and numerous dark places are edged with a faint glow, often merging insensibly into adjacent bright nebulae. Sometimes the dark nebulae themselves have a leaden or tinted aspect, as Barnard's visual observations have shown. There are even comparative degrees of darkness, or "gradations of obscurity," as Miss Clerke puts it; some spots are darker than others and remind one of the umbrae and penumbrae of sun-spots, as Barnard has remarked. Thus the less dark spots must "shine" with a very faint glow. There are many gradations of luminosity among the vast, irregular nebulae in the Milky Way. In Sagittarius Barnard describes a small black hole in the Milky Way, like a black planetary nebula, round and sharply defined and not due to the presence or absence of stars. In the photographs of the Taurus region the dark lanes brighten and darken again—stars are absent from them and they seem to be independent of the stars. In the

photographs of the region around Rho Ophiuchi the nebulous material is actually condensing around the stars, and the dark lanes are in intimate association with both nebulae and stars. Near this star there is a great dark lane running east and west and Barnard mentions a case where the telescope in observing transits of stars had been unintentionally placed on this rift, with the result that no stars appeared—the rift was slowly drifting from east to west through the field of the telescope. This rift suggests the great cleft which divides the Milky Way into two streams and extends from Cygnus in the northern to Centaurus in the southern hemisphere. Perhaps it would strain the facts to assume that this long bifurcation is caused by a dark mass absorbing the galactic light behind it. Turner in counting the stars of various magnitudes in the great Astrographic Catalogue, has found evidence of two large tracts of nebulosity where there are not enough faint stars in comparison with the bright ones. He suggests that a great cosmic cloud veils the light of the more distant stars.

As some of these objects are projected against space itself, without a background of stars or nebulae, Barnard thinks that space is faintly luminous, enough to show a dark object in relief. See also says that the background of the night sky is faintly luminous. Barnard makes an interesting comparison between photographs of the net-work nebula in Cygnus and its analogue, a dark object in Cepheus. They are similar in shape, but one is bright and the other dark. He suggests that nebulae die out just as stars do. Hind's variable nebula in Taurus is an example of a nebula formerly bright in small telescopes, but now so faint that powerful glasses only show it with difficulty. As these dark objects are opaque enough to absorb the light of the stars lying beyond them, Barnard thinks that they are relatively dense and more massive than ordinary nebulae. Thus they must exert a considerable influence on the movements of the stars taken as a whole. Eddington says that there is even some of this absorbing nebulosity within the limits of the central aggregation of stars of which the sun is a member, although most of it is involved with the star-clouds of the Milky Way.

Some years ago Holden, in comparing Sir John Herschel's observations of the Trifid nebula in Sagittarius with recent observations, noticed that a star formerly in the middle of a dark lane and presumably in front of it, was on the bright edge of the nebula. As the star had not moved with reference to neighboring stars, it would seem that the bright and dark parts of the nebula had drifted away from the star. Campbell has recently measured the radial velocities of a number of irregular gaseous nebulae by the spectrograph, and finds that they have small average motions. The extended gaseous nebulae congregate in or near the plane of the Milky Way and as the

dark nebulae often appear to be stagnant extensions or margins of their bright companions, we may infer that they too are mostly gaseous and possessed of small radial velocities. Campbell has also shown that hydrogen is glowing on the confines of the Orion and Trifid nebulae, while he finds nebulium in the centers of these nebulous masses. These observations imply that the darker clouds are principally composed of hydrogen. (The same is true of certain planetary nebulae and the ring nebula in Lyra, according to the investigations of Wolf and Burns, and Wright). It is possible that some of these dark objects may shine by reflected light. Such is the case with the nebula surrounding the star Merope in the Pleiades, as Slipher has shown by the spectrograph. The new star in Perseus which blazed forth in 1901, illuminated a nebula which previously was not known. Novae (or new stars) always appear in or near the plane of the Milky Way, where the chances of a collision with dark or lucid nebulae are much increased.

Eddington, Slipher and others have recently presented strong evidence that the spiral nebulae are external Milky Ways. The absence of measurable parallax and proper motion, combined with Slipher's discovery of great radial velocities, strengthens the probability that they are outlying universes. Slipher finds that the spirals give a spectrum similar to that of the sun and rather advanced in spectral type, and Fath has shown that the integrated spectrum of the Milky Way is solar in type. Similarity of spectral type implies that the spiral nebulae and the Milky Way belong to the same class of objects. Photographs of spiral nebulae which happen to lie edge-wise to our line of sight show a long dark rift dividing the nebula equatorially. The Milky Way if viewed edge-wise would present a similar line of light divided length-wise by dark absorbing nebulosity. As the sun is almost in the plane of the Milky Way, we look towards the dark nebulae and are prevented from seeing objects lying beyond them. Thus the external spiral nebulae are for the most part invisible in and near the plane of the Milky Way, but appear in great numbers the farther we look away from it.

Where do the dark nebulae belong in the scale of cosmic evolution? In view of their intimate association with the extended, gaseous nebulae of the Milky Way, it is probable that they precede the latter and thus are at the very beginning of cosmic evolution.

THE HISTORY OF THE DISCOVERY OF THE SOLAR SPOTS.

WALTER M. MITCHELL.

[*Concluded from page 499.*]

SCHEINER AS A PLAGIARIST?

To return to the accusation of plagiarism which has been made against Scheiner. There have come down to us, in the correspondence between Galileo and his friends, statements which show that the learned Italian believed that Scheiner had at an early date received news of the discovery of the spots and had acted on this to his disadvantage. The chief evidence for this is contained in a long letter from Galileo to Alfonso Antonini, dated 20th February 1638. The letter was written some years after Galileo's condemnation by the Papal Tribunal, and was principally concerned with the librations of the moon. Galileo writes:*

It grieves me that I cannot give you complete satisfaction, and especially because of your having requested it of me with so much affection, and at the same time have shown yourself very jealous that another one having been able to learn of this novelty which was discovered by me, should wish to make himself the first observer of it, as has happened with other admirable observations of mine, and in particular with the solar spots, where Christoforo Scheiner with such boastful audacity, not only boasted for himself priority in time of discovery, but conjecturing more judiciously than I, was able to discourse on the nature and behaviour of these spots, expecting nothing less from the ignorance of his reader than from his own arrogance. And, as if he had not already published in printing his three letters so full of ignorance and all the errors that can be conceived of, and on the other hand having seen similar letters of mine written about the same observations, but full of conjectures, all of which have since been verified, he, attributing to himself all the truths which he has learned from me, makes himself in the Rosa Orsina, or Orsa Rosina as indeed he gracefully changes it, the author of all truths and defames me as a most ignorant man. For clear evidence of his vanities and of my correct reasoning it is sufficient to read the above mentioned letters by me and by him, which are printed together in one volume. As to his having seen these spots a long time after me, in addition to other testimonies; there are two from two Fathers of the same order. One of these is Father Adam Tanner; in his *Astrologia Sacra*,† on page 49 I read these words, "Assuredly the great astronomer Galileo, the first discoverer of these wonders of the skies, maintains that these spots which overshadow the sun are, etc." And your Grace should know that his Father lived in Ingolstadt, and lectured at the same college with Father Scheiner, and indeed at

* *Gal. Op.* **17**, 296.

† *Astrologia Sacra, hoc est orationes quinque, quibus explicatur an et qua ratione fas sit homini Christiano de rebus occultis, praesrtim futuris, ex astris iudicum ferre, ecc.* Ingolstadtii, 1615.

the same time that the latter was making observations of these spots; and as you see he calls me the first discoverer, nor does he mention Scheiner in his whole book. As for the other Father, I prefer not to mention his name at present, but he is still living and he affirms that he was the first who gave information to this Father Scheiner regarding the spots exhibited by me during the time that I was in Rome, where on various occasions I showed them to many great prelates in the Quirinal Gardens, which happened many months before Scheiner mentioned it in his letters to Marco Velsero, Duumvir of Augusta. But why does this lunatic desire to make himself precede me in the time of his discovery, and these observations regarding which he discourses so foolishly, while I lacking observations announce so many conjectures, since confirmed as undoubted truths?

The identity of the Father to whom Galileo refers, and whom he 'prefers not to mention' is made clear by two letters from Giovani Pieroni, Imperial Engineer, and a former pupil of Galileo. The first of these is dated January 4, 1635, from Neustadt near Vienna, Pieroni writes:*

There is found in these parts Father Sciainer (Scheiner) with his "Rosa," which is likely to rot, because having brought here many copies of that great wretched book he cannot dispose of them, and he is angry thereat. I have seen [a copy of] it, loaned to me by a person who knows and esteems you, and who associated with you in Rome, and who has told me that he remembers as clearly as one can say that he remembers anything that he was the first who told Father Sciainer that spots were seen on the sun which were first discovered by yourself. Hence, I have a living witness that the first book of that volume is false.

Naturally there followed an inquiry from Galileo concerning the identity of the "person" referred to. Pieroni replied, October 10, 1637:†

Father Guldino has published here his book *De centro gravitatis*, and he has given me a copy to send to you whom he esteems and reveres greatly, ...This Father is the one who assures me that he was the first to inform Father Scheiner of the spots on the sun discovered by yourself.

Concerning the probable accuracy of these statements, Favaro shows‡ from the most trustworthy sources that Guldino, who became a Jesuit in 1597, was at Munich until 1609, and afterwards, "since his extraordinary aptitude for science had on various occasions shown itself, he was called to Rome and ordered to devote himself to philosophy and mathematics,"¶ remaining there until 1617 when he went to Vienna. Consequently Guldino must have been in Rome during April 1611, at the time when Galileo was publicly exhibiting the spots. He would have been attracted by such matters, and hence, there can be no doubt of the possibility of his communicating with Scheiner as above indicated. Particularly as Scheiner and Guldino had become acquainted

* *Gal. Op.* **16**, 189.
† *Gal. Op.* **17**, 193.
‡ *Op. cit.* p. 748.
¶ *Bibliotheca Scriptorum Societatis Jesu*, Romae, 1676. p. 647.

while at Munich, and afterward maintained an active correspondence on scientific matters.

From this evidence it seems safe to assume that the statements of Pieroni are substantially correct. Galileo, as we have seen, arrived in Rome on March 29. How soon after his arrival he exhibited the spots in the Quirinal Gardens, we have apparently no means of determining. It seems safe to assert that the spots must have been exhibited before the 24th of the following April, for on that day the commission of the Collegio Romano reported its findings to Cardinal Bellarmine. However, Fahie states:*

> Immediately after the report of the Bellarmine commission, Galileo announced a new discovery in the heavens, namely, dark spots on the body of the sun, which, toward the end of April 1611, he showed to several prelates and savants in Rome.

Fahie does not mention the source of this information, and hence we are uncertain whether it is mere conjecture, or is based on real evidence. In any case Guldino's letter would not have left Rome much before the latter part of April. Since in those days means of communication were slow and uncertain, Scheiner could not have received the letter before the end of May, as is pointed out by von Braunmühl. That this is a reasonable limit, is learned from the fact that Galileo's second letter on the spots to Welser, forwarded on the 23rd of August from Florence, was not received until the 2nd of October.† But in the first letter to Welser, dated November 12th, 1611, Scheiner asserts that his first observations were made seven or eight months previously, that is, one or two months before he could have heard of Galileo's discoveries through Guldino's letter. Hence Pieroni's letters cannot be considered as evidence that Scheiner was a plagiarist.

However the most important point in the discussion is whether or not Scheiner actually saw the spots for the first time in March or April 1611, as he asserts in the letters to Welser and in the *Rosa Ursina*. This is a question which it seems impossible to solve by any direct evidence. But if a condemned man should be pardoned because convicted by circumstantial evidence only, the writer believes that Scheiner should. He states in the *Rosa Ursina* that his first observations were made in the presence of Father Cysat. Cysat died in 1657, or more than twenty five years after the publication of the book, so that one can hardly believe that Scheiner's assertion is a deliberate falsehood. But, if Cysat had agreed to enter a compact with Scheiner to maintain the claims of the latter, it would have been more natural for Scheiner to have placed the time of the first observation at a far earlier date, in

* *Op. cit.* p. 128.

† *Gal. Op.* **11**, 407.

order to avoid all possibility of suspicion that he had received news of the discovery made in Italy.

In the preface to the *Rosa Ursina*, as we have seen, Scheiner asserts his innocence of any previous knowledge of the existence of the spots.

> Father Tanner perceived the same spots,.....on account of some previous rumor, as he says, of which, however, not the faintest whisper reached my ears.

But Scheiner's methods have not established his reputation for veracity on matters of this character. However, Welser comes to his aid, and asserts in the letter of March 16, 1611, to Johann Faber, already quoted, that Scheiner knew nothing of Galileo's discovery:

> Moreover, I can affirm that my friend who calls himself Apelles, knew nothing of the observations of Galileo.

The strength of this testimony cannot be denied, for the honorable Mayor of Augsburg held Galileo in the greatest esteem, and was also a life long friend of Scheiner; although it must be admitted we do not know how he learned all the facts of the case.

With the sincerity of Scheiner's declarations, and the pleasure that he showed because of the agreement between his own observations and those of Galileo, as quoted by Welser in another letter to Faber,* Domenico Berti was so impressed, and remarking that he found such a clear imprint of truth, was forced to believe that Scheiner had discovered the sun-spots without any knowledge of the previous observations of Galileo.†

On the other hand there is no doubt that Galileo's observations, whether made at Padua or in the Bandini Gardens at Rome, were well known in Germany. The letters of Welser to Paolo Gualdo, to Johann Faber, and to Galileo testify to this. Even Scheiner, in the above quotation, tells us that while he was making his October observations, Father Tanner at the same college was also observing the spots on account of some previous rumor, of which Scheiner says he was ignorant.‡ But this was in October; how much previous to this the spots were known in Germany is not apparent. Wohlwill, in discussing this question believes¶ that the "previous rumor" refers to the *Narratio* of Fabricius, which had come to Ingolstadt from Frankfurt. This does not seem probable when we recall how little known was the *Narratio*, and the difficulty that Kepler had in obtaining a copy. Tanner, as we

* *Gal. Op.* **11**, 428.

† *Memorie della Reale Accademia dei Lincei, Scienze, Morali, etc.* Serie 3, **10**, 7. Roma, 1882.

‡ Circumstantial evidence does not support Scheiner in this, however.

¶ *Arch. Geschichte der Naturwissenschaften und Technik.* **1**, 443. (The author has not had access to this reference.)

have seen, refers in his *Astrologia Sacra* to Galileo as the first discoverer, and hence it seems more probable that the "previous rumor" was of Galileo's observations and not those of Fabricius.

From all this, the most reasonable deduction is, that Scheiner did see the spots independently as he asserts, in March or April 1611; but on account of doubts of their reality, strengthened by the admonitions of Busaeus, kept the knowledge of them to himself. On the receipt of Guldino's letter in the summer or early autumn of 1611, he again turned his telescope to the sun, and the doubts as to the reality of the spots having been removed by the knowledge that they were seen elsewhere, became convinced that they were real objects of some sort, and wrote the letters to Welser in order to prevent the discovery being "snatched from his hands" by forestalling Galileo in the announcement. This view is strengthened, when we recall the stress that Scheiner places upon the fact that Galileo had failed to make the proper announcement of his discovery, and that on this account his claims for priority were not worthy of recognition because having no foundation or support.

Summary and Conclusion.

Considerably more might be written about the early observations of the solar spots, but space will not permit. The four men whose observations have been discussed are worthy of particular note, because they must be considered as independent "discoverers." Others whose work was perhaps less important were contemporaries or followed them; such were Simon Mayr, Kepler, Hevelius, Gassendi, etc., but the observations of these were only made after knowledge of the existence of the spots had come to them; consequently their observations have not been considered in the present discussion.

Concerning the inaccurate statements found in the various histories of astronomy concerning the discovery of the spots, all that need be said is that the earlier historians were not in possession of the facts as we know them today. If Grant, Delambre, and others had had access to such works as the *Edizione Nationale* of Galileo's works, it is safe to venture that the erroneous statements for which they are responsible, would not have been written.

Galileo was the first to observe the spots with the telescope. His first observation was made at Padua during the summer of the year 1610. The reasons for asserting this have been related at length; briefly they are, Galileo's own statements as contained in the letter to Guiliano

de' Medici and in the *Dialogues*. These statements are confirmed by Micanzio's letter of September 27, 1631, and by Viviani's *History*.

The public exhibition and demonstration of the spots was made in Rome during April or May 1611; the evidence supporting this is contained in the letters from Piero Dini, Angelo de Filiis, Agucchi, and the Jesuit Maelcote.

Galileo's first mention of the spots in a written document, is in the letter of October 1, 1611, addressed to Cigoli. From the wording of this letter it is very evident that Galileo had been aware of the existence of the spots for some time previously. The first printed publication in which he mentioned the spots is the *Discourse on Floating Bodies*, completed in October 1611, and published in May of the following year.

Following Galileo, Thomas Harriot appears to have been the next observer of the spots with the telescope. Harriot's first view of the spots was obtained on the 8th of December 1610; the evidence for this is the original observation itself.

Johann Fabricius' first observation, as related by his father David, in the *Prognosticon Astrologicum* for 1615, was made on the 27th of February 1611. Fabricius was the author of the first printed work in Europe containing an account of the spots; this bore the date of dedication June 13, 1611, and appeared from the printer in the fall of that year.

The first observations of Christopher Scheiner, as related in the letter to Welser and in the *Rosa Ursina*, were made during March or April 1611. There is no evidence to support these assertions other than Scheiner's own statements; but from the circumstances it seems reasonable to accept these as an account of the actual facts. The first letter to Welser was dated November 12, 1611, the earliest recorded observation October 21, 1611.

The observations of Fabricius and Harriot were, from the scientific standpoint, of small value. However, Fabricius' *Narratio* contains the first statement of the probable solar nature of the spots and of the rotation of the sun. Fabricius perceived that the changes in the motions of the spots across the disk might be the result of foreshortening, the spot being situated on the surface of the rotating sun. But, from fear of adverse criticism, Fabricius expressed himself very timidly.

To Galileo really belongs the credit for first asserting that the spots were a part of the sun, and, once convinced of this, he unhesitatingly supported his assertions with conclusive proofs and arguments. The first announcements of the sun's rotation, of the faculae, of the granulation, and of the spot zones were made by Galileo.

Scheiner's earlier observations were of small scientific value, owing

chiefly to his belief in the "spotless sun" of the Peripatetics; but this is by no means true of his later observations. These observations, when one considers the crude instruments at Scheiner's disposal, were extraordinarily accurate, as was the determination of the elements of the sun's rotation; and for these he deserves the highest praise. The great *Rosa Ursina*, longwinded or "inflated with conceit" as certain parts of it may be, stands as a splendid monument to Scheiner's perseverance and skill; and one can only regret that the contents of this remarkable book have been so generally unknown.

Numerous attempts have been made by the supporters and friends of Scheiner to discredit Galileo, and to proclaim the Jesuit as the discoverer of the solar spots. These attempts can be traced directly back to Scheiner's time, and have been made largely by those whose religious views have affiliated them with him. Their efforts have been particularly unfortunate, in that they have reacted to produce the opposite effect from that intended; for they have tended to prejudice opinion against Scheiner, rather than in his favor, and have brought the relatively unimportant question of discovery into prominence, while the more important facts and results deduced by the early observers have been generally overlooked. This policy on the part of Scheiner's over zealous supporters will probably explain why so little is known today of the contents of the *Rosa Ursina* or of the *Istoria e Dimonstrazioni*; few historians of astronomy mention even the existence of the latter, much less its contents, while the *Rosa*, because of Delambre's unfortunate and unjust criticism, is generally regarded as a subject only for jokes. In truth one must admit, as Micanzio states, the mere size of the book would tend to discourage readers; but if so much energy had not been wasted in the controversy over the discovery, more would be known today of Scheiner's observations.

Concerning the attempts to discredit Galileo, a few words may not be out of place. The chief argument has always been that the assertions of Galileo in claiming the discovery were not to be relied on because there were no records of actual observations to support them; while the statements of Micanzio and Viviani were either ignored, or their truth denied. Also, that inasmuch as Scheiner's first letter to Welser preceded Galileo's by some six months, Scheiner must certainly have been the first to see the spots. But the public demonstration at Rome, concerning which there can be no doubt, for even the Jesuit Maelcote testified to it, and he was distinctly not a partisan of Galileo, preceded Scheiner's first authentic observations of October 21, by half a year. Even disregarding this, Galileo's letter to Cigoli, dated October 1, 1611 preceded Scheiner's observation by several weeks. Consequently

there can be no real reason for maintaining that Scheiner saw the spots before Galileo.

The weak side of the argument, which clearly shows the personal bias of Scheiner's supporters, is that Galileo's statements, confirmed as they are, have not been regarded as truths, while Scheiner's assertions of his observations of the spots in March or April 1611 have always been accepted without question, notwithstanding that these assertions are absolutely unconfirmed by any evidence whatever. Even Cysat, who appears to have been present at the time, preferred to remain silent, even during the quarrel which followed, for there is no statement from him affirming or denying the truth of Scheiner's assertion; at least no evidence of any such statement has come down to us.

Thus we have traced the history of the discovery of the solar spots from the time of the first observations by Galileo to the publication of the *Rosa Ursina* twenty years later. It is doubtful if at any period of the development of solar astronomy have such vast strides forward been made in so short a period of time. During these twenty years were discovered all the important phenomena ordinarily visible on the sun's surface as we know them today, with one exception—the periodicity of the spots, which was not announced until 1843. The two hundred years following the publication of the *Rosa Ursina*, although most fruitful in planetary discoveries and in the development of mathematical astronomy, were practically blank as far as solar discoveries were concerned. This seems rather remarkable when we recall that such men as Huyghens, the Cassini's, Roemer, Flamsteed, Halley, Bradley, etc., were actively engaged in observational astronomy during this period. Possibly it was as Weidler suggests, that Scheiner "had conquered himself, the sun, and posterity in despair of any better observations," so that nothing remained to be discovered unless with the aid of new instruments of research.

With the attempts by Galileo, Scheiner, and the early observers to explain the perplexing phenomena observed on the face of the sun with the assistance of the laws of physics and chemistry as they were known at that time, was born the new science of Astrophysics. This science is not concerned with the positions or movements of the heavenly bodies, but instead considers the equally important questions of their constitution, and the physical and chemical conditions that prevail upon them.

Two hundred years later, studies of the sun's light brought about the first great advances in the new science of Astrophysics. Through the investigations of Wollaston, Fraunhofer, and Brewster, which finally culminated forty years later in the epoch making researches in spec-

trum analysis by Kirchoff* and Bunsen, are we now able to recognize the chemical elements present in the sun and other celestial bodies, and to gain some knowledge of the physical conditions on these bodies under which the elements make themselves manifest.

Looking toward the future, it seems that the greatest advances in Astrophysics must come through the study of solar phenomena. In the sun we have a typical star, placed close at hand, and with the insight and knowledge gained by the study of its phenomena, coupled with intelligent and well directed laboratory research, we may be able to solve the extraordinarily perplexing problems presented by our more distant stellar neighbors.

As with the first studies of the sun was born the new science of Astrophysics; to be nourished to sturdy youth, after a long and uneventful childhood, by the investigations of the sun's light in the early part of the last century; so at the present day, the knowledge that will later bring about the growth and development to maturity of this new science must be looked for from the same source. Then, as we consider the phenomena of the stars, and the multitude of problems that are there presented to us for solution, let us hold ever before us the words of Scheiner:

> These and other questions of celestial physics arouse us to the opportunity offered by these phenomena. He, who wishes to solve them truly and correctly without deceit or falsity, will resort to the sun, and from this will elicit better answers that from the Delphic Tripod and Apollo himself.

Philadelphia, Pa.
January 1915.

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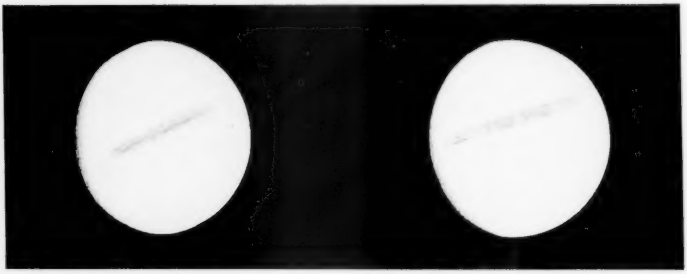
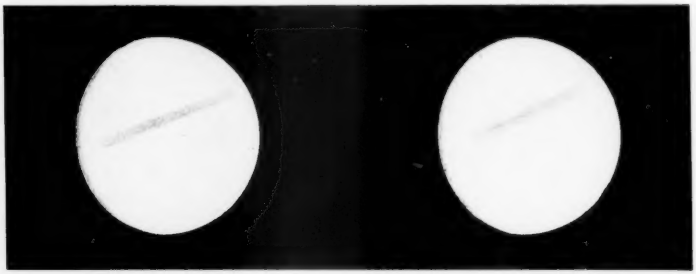
* It may be remarked that although almost universally credited with the discovery of spectrum analysis, Kirchoff was not the first to discover the all important relation between spectrum and element, nor was he even the first to announce the discovery of this relation. It has recently come to light, through the researches of Dr. W. J. Holland (*Annals of Carnegie Museum of Pittsburg* **8**, 215, 1912) that this honor rightly belongs to Dr. David Alter of Freeport, Pennsylvania, who published in 1854 and 1855 in Silliman's *American Journal of Science* (Second series, **18**, 55: **19** 213) the announcement of this discovery, mentioning the applicability of the method of spectrum analysis to the study of celestial phenomena.

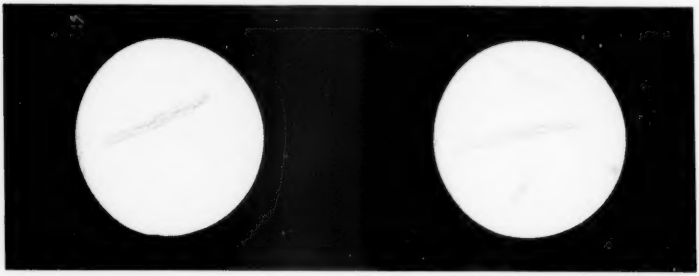
PLATE XXXVII



June 9 $2^h\ 15^m$ Gr. M. T. June 21 $0^h\ 10^m$ Gr. M. T.



June 23 $0^h\ 45^m$ Gr. M. T. June 23 $23^h\ 50^m$ Gr. M. T.



July 7 $3^h\ 15^m$ Gr. M. T. July 19 $0^h\ 45^m$—$5^h\ 30^m$ Gr. M. T.

DRAWINGS OF VENUS IN 1915 ILLUSTRATING THE ELIMINATION OF THE PERSONAL EQUATION.

A BRIEF NOTE ON A NEW DETERMINATION OF THE NATURE OF THE ROTATION OF VENUS.

DAVID H. WILSON.

With the view of learning something about the rotation of Venus, I observed her during every hour of steady air from December 15, 1914, to March 10, 1915, and from June 5, 1915, to September 1, 1915. Half of the time I used the 20.4-centimeter Brashear refractor of the Philadelphia Observatory; the rest of the time I used any one of three other instruments, all located on the site of the Flower Observatory of the University of Pennsylvania. Though the latter site is in the eastern part of the United States, the local topography assures the equality of the definition at noon to that at night. As Venus was never far from the sixth hour of right ascension when I made my best observations, the steadiness of the air usually remained fairly constant for five or eight hours at a time, for it was independent of the heating of the sun and largely dependent upon the altitude of the planet. These circumstances, together with several others, occasionally permitted me to see the very delicate markings on Venus with certainty. See the accompanying plate. The boundaries are somewhat too sharp, for the low powers used to secure contrast made the detail look sharper than it really was.

It is necessary to be very cautious in reaching conclusions from objects at the limit of perception. Therefore I tested very thoroughly the reality of the chief marking in these drawings.* One method of testing it was to change the orientation of the image by rotating a prism eyepiece, so that the streak would appear in an entirely unexpected position. The result was very successful, for tests repeated frequently enough to eliminate chance gave values for the position-angle of the streak in remarkably close accordance.†

The prism obviated the possibility that the streak had its origin in the mind, the eye, the eyepiece, or in the prism itself. The streak

* No drawings showing this marking at its best have been omitted. But there are also some drawings showing the planet at different phase.

† The best examples of this test are the drawings of June 9 and July 7. These have been mathematically oriented from the original drawings. But the observations of June 12 at $2^h\ 30^m$, July 7 at $1^h\ 50^m$ and $2^h\ 25^m$, and July 23 at $4^h\ 0^m$, though not included in this note, confirm the true position of this marking.

could not have been in the telescope, for the same marking was unmistakable in each of four different instruments. It could not have been in the air, for the marking was never clearly seen except when the image was almost undisturbed and the diffraction rings sometimes motionless. In other words the streak could have originated nowhere but on the planet itself.

But there is still more evidence in favor of this conclusion. The orientations of the image were always referred to the celestial poles instead of to those of the ecliptic. For this reason the long streak shifted apparently through the position angle of thirteen degrees in the interval from June 9 to July 7. I was not aware that my drawings revealed this shift in orientation until I examined them almost a year after the close of my observations.*

The drawings of June 21, 23, 24, and July 19 were made without the diagonal, but in the same impersonal way. I made it an invariable rule to do each drawing on a separate sheet of paper, and not to look back on them until toward the close of the observations. Most of the drawings, indeed, looked quite new to me when I re-examined them; and then, for the first time, I saw the successive identity of the chief marking, and discovered that it is well represented in the sketches of the planet made on April 19, 1898, by Douglass and Drew.†

The comparison of the drawings with each other leads to a value of the rate of the axial rotation slightly faster than that of the orbital revolution: the indicated elements of rotation are first, a period of 223.9 days and, second, the perpendicular axis accepted by all of the advocates of the long period.

After making this computation I turned to other drawings for corroboration. Nearly all of the better drawings made in the past forty years show a set of certain more or less permanent markings in common, and not only demand the period of 223.9 days,‡ but contradict the idea of a materially slower rotation.

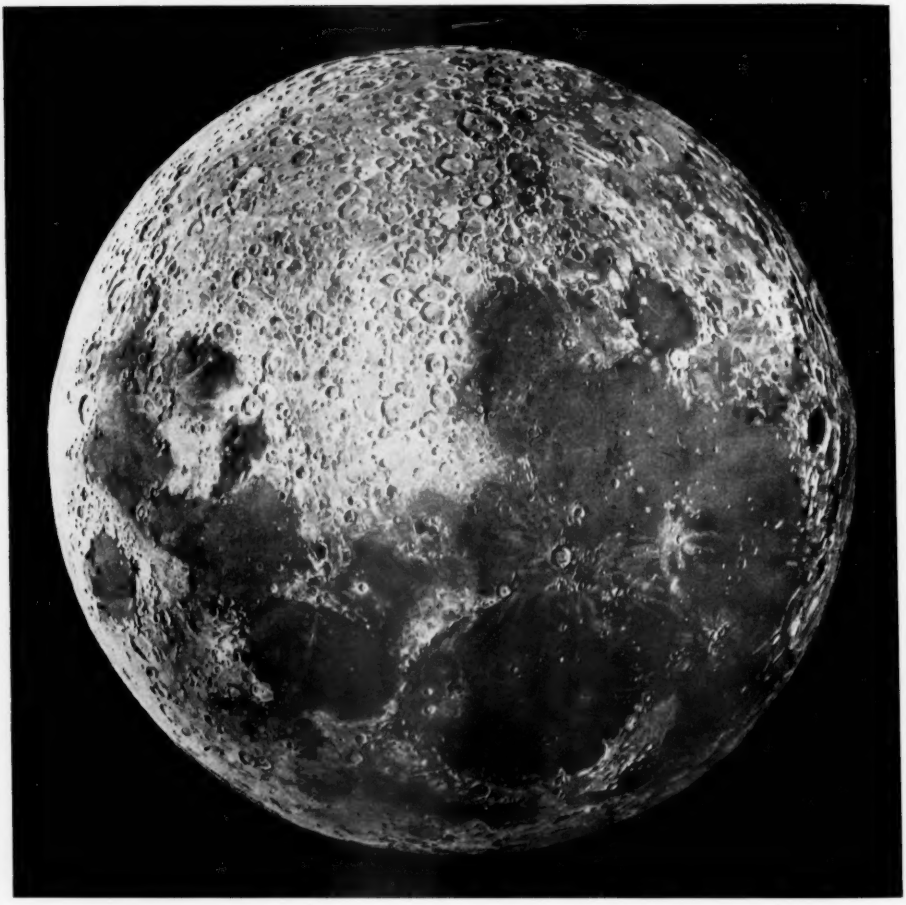
The probability of accidental coincidence has been carefully studied, and the results have been favorable to the new period. The basis of the 223.9-day period appears to be much firmer than that of the other periods proposed up to now. In the first place the slow rotational shift with reference to the sun is indicated very clearly, although the draw-

* See the first five drawings. The probable error of their mean is thirteen times smaller than the quantity measured. I cannot explain the discordance of July 19 except by an error in the placing of the wire then used to get the bearings of the disk, but the main question is not affected.

† Monthly Notices R. A. S., Vol. 58. The possibly illusory nature of the spoke system does not affect the comparison of drawings about to be mentioned.

‡ Even Schiaparelli's various drawings seem to be no exception to the rule.

PLATE XXXVIII



A New Projection of the Moon.
For Use As a Guide at the Telescope.
Copyright 1916 by Russell W. Porter.

ings have been selected without regard to where they were made. As the values derived agree not only qualitatively (with respect to the inclination of the axis and the direction of rotation), but quantitatively (with respect to the exact rotational velocity), the chance of accidental coincidence is very small, especially in view of the large number of drawings measured. Again, chance coincidence is the more improbable, for the delineation of the very same object by the different observers shows unmistakably their respective characteristic ways of seeing it. Representations accidentally similar would not show personal equation of the special kind we are concerned with here. Finally, chance coincidence is very improbable, for certain of the drawings, when measured for the period, show a systematic error of just the kind anyone would predict without regard to the period.

Detailed proof will be prepared as soon as possible.

Philadelphia, Pa., 1916, June 29.

A NEW PROJECTION OF THE MOON
For Use as a Guide at the Telescope.

RUSSELL W. PORTER.

One of the first needs of the student taking up the study of the moon's surface is a means of identifying the different features of its topography. Many maps of the moon have been made for this purpose, drawn from a triangulation of several points scattered over its surface, and the topographical detail filled in by hand. They are all of varying degrees of excellence, and represent a vast amount of time and labor.

With the advent of photography it might be thought that a photograph of the moon, taken at full, would provide one with all that could be desired in picking out any particular marking, but such is not the case. Many of the lunar features are completely obliterated at full moon.

For those familiar with lunar photographs or visual work at the telescope, it is known that only along the terminator, or boundary between the lightened and darkened surfaces, does the character of the topography stand out clear and distinct. It will also be noted that any attempt at assembling, photographically, several negatives taken on the terminator and scattered over the entire moon, would be rendered abortive by their different scales and aspects, due to unequal distances of the satellite from the earth and its changes in libration.

However it seemed to the writer that an improvement over the older charts might be effected by preparing a reseau or net work of meridians of longitude and parallels of latitude, carefully locating thereon the main features from a full moon photograph, and then transferring to this skeleton framework, by hand, the details found on the terminator prints. The accompanying chart Plate XXXVIII is the result.

For existing material, the Harvard plates taken at Jamaica in 1900 were drawn upon. They were made with a twelve-inch objective of 135 feet focus.* The basis is a photograph of the full moon having a libration in longitude of −3.8 degrees and in latitude of −5.6 degrees The details are from the sixteen plates showing the terminator in as many positions distributed over the moon's disc. The sunrise aspect was preferred over the sunset, as being the more likely to be of use. The orientation is that seen through an inverting telescope.

This projection represents an impossible condition of illumination, viz., that of lunar sunrise at every point of its surface. Yet it must be remembered in preparing a map of this kind, that a compromise of some sort must be accepted.

The writer realizes the futility of the artist in attempting to improve on the accuracy and wealth of detail afforded by modern photography. This was not his intention. It was as a means to assist the amateur at the eyepiece that the effort may be considered as in any way justified.

THE ARISTILLUS TEST FOR THE QUALITY OF THE SEEING.

WILLIAM H. PICKERING.

In the former paper, POPULAR ASTRONOMY, **24**, 273, it was stated that the interior canal of Aristillus was being examined at the observatory of M. Jarry-Desloges in northern Africa, and that the writer expected from the quality of the work done at that observatory, that the canal would be resolved. In this expectation he has not been disappointed. With this paper he is able to present, Figure 1, a copy of a drawing of the canal, which M. Desloges has been kind enough to forward to him, and which clearly shows the duplication. It may be compared with the drawing by the writer accompanying the above mentioned article,

* The Moon, by W. H. Pickering (Doubleday Page, N. Y.)

and also with Figure 2 of his first paper on Aristillus, POPULAR ASTRONOMY 1914, **22**, 570. See also the Lowell drawings published in the last February number of this magazine.

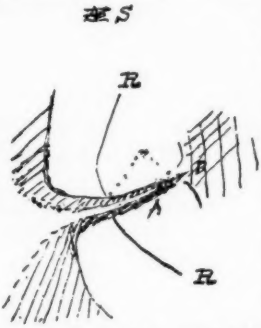


FIG. 1. Aspect general du canal d'Aristillus, entre les onzieme et dixneuvieme jour du lunaison.

A comparison of the drawings made at these three observatories is interesting, because it is probable that they are the only ones in the world where a resolution of this canal is possible at the present time, It might be done at Arequipa, but excepting for photometric work no visual observations have been made there for over twenty years. It might possibly be done at Tucson, but the aperture there, only eight inches, is pretty small for such a difficult object. It is not likely that it could be done at the Mt. Wilson Solar Observatory, because the aperture of the sixty-inch intercepts too large a column of air to be homogeneous, and if the aperture were reduced to twelve or eighteen inches, the large hole in the mirror would seriously interfere with the success of the observation. There is a bare chance that if one of the very fine

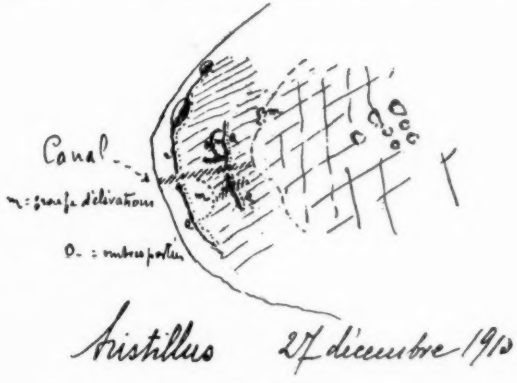


FIGURE 2.

nights that Mr. Phillips occasionally secures at Epsom, England, should occur when Aristillus was favorably situated, he might double the canal, but this seems rather unlikely. Professor Aitken has already given it up at the Lick, and it is doubtful if the seeing is ever good enough at the Yerkes to show it. It is perhaps scarcely worth while to look for the phenomenon elsewhere, but in case any other astronomer

should succeed in resolving it, I hope he will not hesitate to publish the fact, since it is very desirable to know where all the observatories possessing really good seeing are located. On the other hand it is likely that there are a number of observatories where the two outer canals are occasionally visible, and a distinct view of them involves no mean order of seeing, and is worthy of mention.

Referring to the drawing, M. Desloges does not give the date on which it was made, but says it represents the appearance between the eleventh and the nineteenth days of the lunation. This would be in general between colongitudes 40° and 140°. He says "The dark lines of the canal are straight, and the duplication difficult to see, especially towards A and even beyond the crater rim." The writer has inserted the two Rs on the drawing, to indicate the rim. Again he says "The canal appears sometimes to extend only to B, and again sometimes to be prolonged by a greyish zone." See Figure 3 of my earlier paper. He has also forwarded a drawing made on December 27, 1915, colongitude 159°.3. after the canal had again become single. This is shown in Figure 2, This drawing, as he states, shows some very delicate detail, which other astronomers may be interested to verify.

Mandeville, Jamaica, B. W. I.

THE SKIES OF HALLOWEEN.

CHARLES NEVERS HOLMES.

The Harvest and Hunter's Moons are still remembered; but the full Moon of November is three weeks in the future. Over hill and vale we see the blight of early frost; flowers have disappeared, plants have withered, meadows look lifeless. But, under the cheerful rays of October's sun, the foliage of forest and field shines bright in gold and bronze, relieving the depression of a sombre autumnal landscape. Now and then we feel the breath of some colder breeze, suggestive of approaching winter, and the dead, brown leaves at our feet whirl and dance as though suddenly resurrected into life. But King Sol is descending lower and lower, his fiery face passes from sight, a few small clouds reflect his hidden presence, and gloaming settles slowly upon knoll and valley. The day is done—Halloween has come!

One by one, the suns of night awake, to take the place of King Sol. Blue, brilliant, beautiful Vega sparkles towards the westward, and not far distant firmamentally Altair of Aquila glitters against the dim, remote background of the Milky Way. In the northeast Queen Capella

is rising, escorted by winter's brilliant galaxy—the red eye of Aldebaran flashing near the horizon, the tiny group of Pleiades shining higher up. Clearer and clearer appear the suns and constellations of night: the Northern Cross, now descending towards the westward; the great square of Pegasus, below the zenith; the Dipper, at present far to the north; Cassiopeia's Chair, Perseus, Aries, Pisces, Cetus, Aquarius, Capricornus; sun after sun, constellation after constellation, awakening to scintillate and twinkle amid the darkened depth of an illimitable Universe.

And, now, the dome of night is gloriously ablaze with innumerable stars. Sparkling, flashing like celestial gems, they are revolving around and around Polaris, sun-pivot of our firmament. Like a vast sidereal clock are these stars and constellations above us, their respective sky-positions indicating accurately the hour of night. Supernal beacons, also, are they; lighting the darkness of stupendous space. Fiery firmamental furnaces, illuminating and heating the satellites that revolve around them. Like glittering, glowing eyes that never close until King Sol awakens once more in the east. Thousands of such sky-gems are visible to man's unassisted sight; and millions are visible through eyes of powerful telescopes or printed upon photographic plates. A space of hundreds of light-years occupied by multi-myriads of fiery suns and their solar systems. A universe as illimitable as the law and power of Gravity!

Yonder is the Milky Way, shining with its innumerable suns. What is the exact number of those very remote stars? What is their exact distance—how wide is that luminous girdle, visible alike from our northern and southern hemispheres? What is the real reason for its mysterious presence? Where are we of a tiny planet situated with respect to this so-called Milky Way? Are we nearer to that part of the Milky Way seen from our southern hemisphere than we are from that part viewed from our northern hemisphere? Above us, all around our earth, this dimly shining circle of myriad suns is visible, surrounding like some titanic sidereal frame innumerable stars and star-systems. Why is it there?—for what purpose exist the suns and satellites within it?—what know we of the Universe that lies beyond the confines of our remote Milky Way?

Time passes, and we see some planet, shining placidly amid the darkened firmament. Millions of miles distant, yet how near that shining body seems after such a stupendous excursion into illimitable space! Like a veritable solar mirror, framed by the darkness of night. Like a golden gem set amid sparkling, fiery diamonds. A world belonging to our own system, surrounded by its revolving satellites. Shining with the steady light of hidden King Sol, that placid planet reflects

those solar rays to our earth. A passive celestial body, not to be compared with any one of the myriad suns sparkling and scintillating above us.

The skies of Halloween!—The darkened firmament, just as October passes into November. On earth, there is hereabout the spirit of weird imagining—another revival of an old custom. Goblins and witches return to life; eerie fancies become realities. Fearsome shapes and shadows lurk all around us. It is indeed an evening of childhood memories and old-time traditions. But, overhead, the suns of night are twinkling in splendor—wholly unchanged. Blue Vega, bright Altair, are descending towards the westward; brilliant Capella, ruddy Aldebaran, are ascending out of the, eastward. The less conspicuous stars of autumn are about to be replaced by the more conspicuous stars of winter. It is a sort of sidereal interim. The suns and constellations of Halloween are sparkling above us; the same suns and constellations that gleamed and glittered when we were children, many, many years ago!

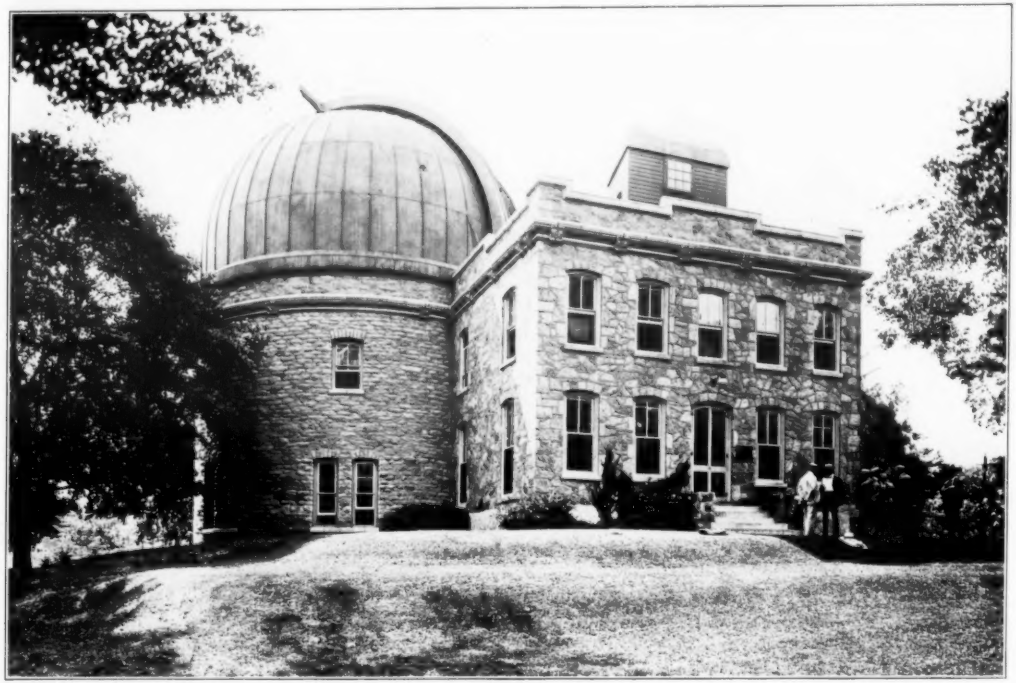
Windsor House.
Gardner, Mass.

NINETEENTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

The nineteenth meeting of the American Astronomical Society was held at Swarthmore College, Swarthmore, Pennsylvania, on August 30 to September 2, 1916. The plan of housing the members in college dormitories, used at Evanston, was adopted here, with similar comfort and pleasantness. The college dining room was opened to accommodate the Society. As all meetings were held in the Sproul Observatory, the sleeping quarters, dining room, and meeting place were all within two or three minutes walk of each other.

It was particularly happy that we could be greeted to Swarthmore College by its President, Dr. Joseph Swain, once a student of Astronomy under Piazzi Smyth. We may be privileged to doubt whether his knowledge of Astronomy is as completely dissipated as he would have us suppose. We prefer to believe that, while it may have merged into the background of broadened scholarship, the interest in Astronomy might again call it forth to attack with success the new problems. In any case, the interest was so genuine and his welcome so cordial that

PLATE XXXVI



THE SPROUL OBSERVATORY

it was a pleasure to us all to be at Swarthmore. He recalled his early association with Professor Miller, at the University of Indiana, and specifically the action of the Trustees on Professor Miller's request for a new telescope which should be of nine inches or, if possible, of twelve inches aperture. He spoke of Professor Miller's discomfiture when the Trustees, in bantering spirit, informed him that they did not find it possible to grant his request for a nine-inch refractor, and his joy when, a few minutes later, they announced that he might have a twelve-inch telescope. A somewhat similar episode occurred on his coming to Swarthmore, at which time he had asked for an eighteen-inch, or better, a twenty-four inch telescope. The Honorable Senator William Cameron Sproul, who provided the funds for the twenty-four inch refractor, reviewed the incidents leading up to his gift. He paid a glowing tribute to his former teacher, Miss Susan J. Cunningham. She seems to have impressed the love of truth and learning on her students in an extraordinary degree. In this case it is bearing ample and very substantial fruit.

President Pickering replied to these addresses of welcome, and the meeting started off pleasantly, and with a feeling of great cordiality.

The scientific program was divided into six sessions: Wednesday morning at ten o'clock, and afternoon, at two o'clock; Thursday at the same hours; Friday morning at nine, and Saturday morning at half after nine o'clock. Fifty-two papers were presented, and also reports from various committees. Certain reform must soon be made in our program, for the various meetings show an increasing number of papers, and soon our sessions will be seriously overburdened with their presentation, crowding out opportunity for discussion, committee meetings, and general conference, which, after all, are the most valuable part of the meetings.

Several very enjoyable social features were provided for our entertainment. On Wednesday evening, Mr. and Mrs. Miller invited us to their home, where, at a reception, we had the opportunity to see their pleasant home, and to meet many of their friends and neighbors. On Thursday evening, we were driven in automobiles to the home of Senator Sproul, Lapidea Manor, where he and his wife received us most cordially. After a stroll about the grounds, from which we had a fine view across the low rolling hills to Chester, we sat down to what was styled a "Pennsylvania Country Supper." President Joseph Swain, President Isaac Sharpless of Haverford, and Provost Edgar F. Smith of the University of Pennsylvania, as well as other guests, friends of the College and Observatory, were with us. We spent the evening inspecting the many art and antique treasures of the Sproul home.

On Friday at noon we were taken in hand by a group of Swarthmore citizens, who took us in their automobiles on an excursion to historic Valley Forge, of which it is written, "No spot on Earth—not the plains of Marathon, nor the passes of Sempach, nor the place of the Bastile, nor the dikes of Holland, nor the moors of England—is more sacred in the history of struggle for human liberty." We visited here the various points of interest, and saw the many relics and memorials. Of especial interest at this time, when most of the world is represented by thousands of soldiers burrowing in trenches, were the still clearly visible lines of entrenchments prepared by Washington's army. The day was rather warm, and it required somewhat of a stretch of imagination to picture the sufferings from the cold of the ragged and poorly shod and famished continental army, Our way on the return took us through the campus of Bryn Mawr College. We drove into the quadrangle, and looked about at some of the buildings. It is certainly a most attractive place, even without the young ladies—for school was not in session—harmonious and beautiful in detail and ensemble. Leaving Bryn Mawr, we went on to Haverford College, and found ourselves in surroundings no less beautiful than we had left. Fine lawns, beautiful trees, and adequate buildings characterize the place. It was pleasant to be welcomed by another Astronomer President, President Isaac Sharpless. Professor E. W. Brown, by virtue of his earlier connection with the College, took the lead, and conducted us to a bower where tea was served, very refreshing after our rather dusty ride. Several members of the Haverford faculty showed us about. Naturally, we took great interest in the Observatory, with its nicely cared for ten-inch equatorial and other instruments, and the monument marking the site of the first Observatory of Professor John Gummere. Finally, on this day of many experiences, we reached the Flower Observatory, at Upper Darby, and were greeted by the Provost of the University, Dr. Edgar F. Smith, and Mrs. Smith, and by the Director, Professor Eric Doolittle, and his wife, and by his predecessor, his father, Professor C. L. Doolittle, and his wife. Certainly there is nothing more worth while seeing than a son so well qualified to be the successor of his father, and a father so worthy of being followed, together.

We were the guests of the University of Pennsylvania for the dinner which was spread under the great trees on the Observatory grounds. The long ride had given us the appetite which is the best spice for food. It was a beautiful evening, after a glorious day, but unfortunately clouds soon covered the sky, and denied us more than a mere glimpse of the stars with the eighteen-inch refractor. Most of the party, after tarrying an hour after dinner, returned to Swarthmore; but a few, in the hope that it might clear, or, failing that, in the wish to see how

Professor Doolittle is caring for the task inherited from Burnham—the custodianship of double star literature—stayed on, and had a very pleasant evening, returning to Swarthmore in the middle of the night.

Among the various features offered for our comfort at Swarthmore, must be mentioned a swimming pool which provided both refreshment and entertainment. One of us, having hung his clothes within a locker, unwittingly twirled the lock, and returning from the pool, found himself unable to solve the combination. I have no doubt that application of the principles of permutations and combinations might eventually have won him his clothes; but a screw-driver was more immediately successful. Meanwhile, inquiry was set on foot as to whether there was a cooper present, and also a lively discussion arose as to just the degree of informality of Senator Sproul's dinner.

On each evening, the dome was opened, and the telescope was placed at the disposal of the visitors, for the observation of such objects as we might wish to view. Either Mr. Pitman or Mr. Mátos was present to manipulate the telescope. As the seeing was not at its best, it was not possible to test severely the quality of the objective. Clusters, nebulae, double stars and the planets Jupiter and Uranus, were exhibited. It was possible for us to see three of the satellites of Uranus. There seems to have been a marked change in the relative brightness of Oberon and Titania on the two nights of August 30 and September 1, Oberon being apparently much fainter on the second night than on the first. For those observers who have had the experience in observing with large telescopes, and have had the convenience of a rising floor, the lack of it at Swarthmore was very emphatic. The rising floor, which is a convenience for small instruments, becomes almost a necessity for large ones.

At the sessions of the Council, some changes were made in the matter of Committees. In accordance with the recommendation of Professor Townley, Chairman, the Committee of Variable Star Nomenclature was discharged. His statement is as follows: "The Committee has not been able to find any common ground on which to stand. Miss Cannon favors the Harvard system of nomenclature, Professor Russell favors the continuation of the present Argelander system, and the Chairman favors the number system. Under these circumstances, the Committee is not able to make progress, and I would suggest that it be discharged." In compliance with the recommendation of Professor Campbell, Chairman, the Committee on Coöperation in the Observation of Radial Velocities of Stars, was discharged. He stated that the 1912 report complied with all the purposes of the act which led to the appointment of the Committee; in short, that the Committee found that coöperation was impractical. This was not the unanimous opinion, but

the prevailing one. The Comet Committee, under the chairmanship of Professor Comstock, having very effectively accomplished its purpose, was ordered discharged, and it was also ordered that the undistributed reports be deposited with the Secretary. A final report of the Committee is given at the end of the account of this meeting.

In view of the coming favorable solar eclipse of June 8, 1918, a Committee was appointed to further and facilitate the coöperation among the members of the Society, and others, for its observation. The personnel of the Committee is as follows: Messrs. W. W. Campbell, Chairman, E. E. Barnard, F. B. Littell, Frank Loud, S. A. Mitchell, and Edison Pettit. The Committee was given power to add to its membership. The Committee on Meteors was enlarged by the appointment of C. P. Olivier, Secretary, E. E. Barnard, W. J. Humphreys, F. R. Moulton, and W. H. Pickering. Professor A. O. Leuschner was appointed Chairman of the Committee on Asteroids, in place of Professor E. W. Brown, who had resigned.

A proposal for the enlargement of the Society by instituting the grade of Associate member was presented by Professor Schlesinger. A Committee of the Society had considered such a proposal, and at the Atlanta meeting, reported in favor of the retention unchanged of our present system. However, a committee, consisting of Messrs. Frank Schlesinger, Chairman, C. A. Chant, G. C. Comstock, Philip Fox, W. T. Olcott, and E. D. Roe was appointed to give the proposal consideration.

At the Atlanta meeting of the Society, it was voted to endeavor to meet with the American Association for the Advancement of Science, at its proposed general quadrennial meetings. Inasmuch as the first of these great quadrennial meetings is to be held in New York, in the coming December, it was decided to comply with the vote made at Atlanta, and meet with the Association in New York, on December 26 to 30, 1916. Further, it was decided, accepting the invitation of Professor Benjamin Boss, to hold the annual meeting of 1917 at the Dudley Observatory, in Albany, New York, in the summer of 1917, the date to be fixed by the Executive Committee and Professor Boss.

At the last meeting of the Society, Professor Schlesinger presented the following resolution, which was unanimously adopted:

> WHEREAS: In the death of Karl Schwarzschild on May 11, 1916, many of the members of this Society have lost a warm friend, the Society itself one of its most eminent members, and Astronomy a brilliant and remarkably versatile contributor;
>
> *Resolved*: That the Society record in its minutes its sense of deep loss, and that copies of this resolution be engrossed and sent

to Mrs. Schwarzschild, and to the Astrophysical Observatory at Potsdam.

Twenty-seven new members were elected to membership in the Society, as follows:

H. C. Bancroft, 412 Taylor Avenue, West Collingswood, N. J.
Ruth D. Bannister, Pisgah, Iowa.
Arthur Floyd Beal, Albion College, Albion, Mich.
Martha Clare Borton, Princeton Observatory, Princeton, N. J.
Frederick Lyons Brown, Dearborn Observatory, Evanston, Ill.
Allan B. Burbeck, North Abington, Mass.
Clifford Charles Crump, Carleton College, Northfield, Minn.
Edith Eleanor Cummings, Laws Observatory, Columbia, Mo.
Clinton Harvey Currier, Brown University, Providence, R. I.
William Ewart Glanville, St. Peter's Rectory, Solomons, Md.
Edward Gray, 2635 Channing Way, Berkeley, Cal.
William Le Roy Hart, Harvard University, Cambridge, Mass.
Francois Henroteau, Detroit Observatory, Ann Arbor, Mich.
William T. Herriott, Allegheny Observatory, Pittsburgh, Penn.
Kiyotsugu Hirayama, Astronomical Observatory, Tokyo, Japan.
Arthur S. King, Solar Observatory, Pasadena, Cal.
Ora Miner Leland, 150 Triphammer Road, Ithaca, N. Y.
C. B. Lindsley, 855 East Ridgeway Ave., Cincinnati, Ohio.
Walter A. Mátos, 309 College Ave., Swarthmore, Penn.
Harriet McWilliams Parsons, Vassar College, Poughkeepsie, N. Y.
Jesse Pawling, Naval Observatory, Washington, D. C.
Edison Pettit, Washburn College, Topeka, Kan.
David B. Pickering, 81 South Burnett St., East Orange, N. J.
William Francis Rice, Wheaton College, Wheaton, Ill.
Robert Trümpler, Allegheny Observatory, Pittsburgh, Penn.
J. van der Bilt, Utrecht Observatory, Utrecht, Holland.
Reynold K. Young, Dominion Observatory, Ottawa, Canada.

On the last day of the meeting, officers were elected as follows:

President	E. C. Pickering
First Vice-President	Frank Schlesinger
Second Vice-President	W. W. Campbell
Treasurer	Annie J. Cannon
Councillors for 1916-18	E. W Brown
	J. S. Plaskett

The following officers continue in service:

Councillors, 1915-17	Edwin B. Frost
	Joel Stebbins
Secretary	Philip Fox

The meeting brought out a wellnigh record attendance, exceeded only at the seventeenth meeting. The following members were present:

Leah B. Allen
A. T. G. Apple
S. G. Barton
L. A. Bauer
A. F. Beal
Harriet W. Bigelow
E. W. Brown
Annie J. Cannon
C. A. Chant
W. A. Cogshall
R. H. Curtiss
C. L. Doolittle
Eric Doolittle
J. C. Duncan
W. S. Eichelberger
Edgar Frisby
Philip Fox
Caroline E. Furness
W. E. Harper
Margaret Harwood
Wm. T. Herriott
Francois Henroteau
Kiyotsugu Hirayama
Mary M. Hopkins
Charles J. Hudson
Louise F. Jenkins
C. C. Kiess
O. M. Leland
Walter A. Mátos
Paul Merrill
Willis I. Milham
John A. Miller
S. A. Mitchell
C. P. Olivier
Edison Pettit
E. C. Pickering
John H. Pitman
John M. Poor
A. W. Quimby
E. D. Roe, Jr.
H. N. Russell
Frank Schlesinger
Frederick Slocum
M. B. Snyder
Joel Stebbins
Hanna B. Steele
H. T. Stetson
Florence J. Stocker
Helen M. Swartz
John Tatlock
Stephen D. Thaw
A. B. Turner
Robert Trümpler
F. W. Very
J. van der Bilt
A. van Maanen
W. R. Warner
D. T. Wilson
W. L. Wright
C. C. Wylie

In addition to the members, there were many visitors:

Ida M. Barney, Marie Bender, Susan J. Cunningham, Mrs. Edgar Frisby, Mrs. Izette F. Hudson, B. H. Lamont, H. A. Markley, Mrs. S. A. Mitchell, Mrs. J. A. Miller, Susan M. Rambo, Susan Raymond, Mrs. Frank Schlesinger, Mrs. Frederick Slocum, Mrs. H. T. Stetson, Mrs. Stephen D. Thaw, Mrs. A. B. Turner, President Joseph Swain of Swarthmore College, President Isaac Sharpless of Haverford College, Provost Edgar F. Smith of the University of Pennsylvania, and Senator William Cameron Sproul.

At the final meeting, Professor E. W. Brown presented the following resolution of appreciation of courtesies:

Resolved: That the Astronomical Society express to the President and Board of Managers of Swarthmore College, its thanks for the courtesies extended to the members of the Society during the meetings at Swarthmore. The Society desires also to express its appreciation of the numerous arrangements made for their comfort and convenience by Professor Miller and President Swain and of the manner in which these have been carried out by the Matron of Wharton Hall and others who have assisted in looking after the welfare of the visitors.

Resolved: That the thanks of the Society be extended to Senator William Cameron Sproul, to the citizens of Swarthmore, to the President and Trustees of the University of Pennsylvania, and to the President and Board of Managers of Haverford College for their hospitalities in connection with the visit of the Society and its appreciation of the courtesies extended to its members.

Resolved: That the Secretary be directed to communicate the substance of these resolutions to Presidents Swain, Smith, and Sharpless, and to others who have assisted.

Less formally, Professor Schlesinger, the First Vice-President, at our last luncheon on Saturday noon, expressed to our hosts very happily, the general appreciation.

At the close of the meetings, the visitors hastened their departure, to reach their several destinations before the threatened railroad strike might be an actuality.

ABSTRACTS OF PAPERS.

RECENT STELLAR SPECTROSCOPIC RESULTS.

By Walter S. Adams.

The method of determining stellar parallaxes from relative line intensities in the spectra of stars has been applied to several groups of stars with measured parallaxes. These results may be summarized as follows:

1. The parallaxes of 28 stars of small proper motion have been determined recently by van Maanen with the 60-inch reflector of the Mount Wilson Observatory. Of these 17 have parallaxes of less than $+0''.02$, the average value being $+0''.008$. The spectroscopic method gives an average value of $+0''.010$. Seven of the remaining stars have an average measured parallax of $+0''.034$: the spectroscopic value is $+0''.023$. In the case of the remaining four stars the spectroscopic parallaxes are lower than the measured values ranging between $+0''.06$ and $+0''.10$.

2. The parallax of the stars belonging to the Hyades group may be calculated with high precision from the motions within the group. Kapteyn's value of the parallax is $+0''.024$. Spectrum photographs of the four brightest stars yield an average absolute magnitude of $+0.3$, or a parallax of $+0''.020$.

3. Barnard's large proper motion star is found to have a spectrum of type Mb and to belong to the "dwarf" class of M stars. Its parallax as estimated from the spectrum should be of the order of $+0''.2$. Its radial velocity is -93 km.

4. The spectroscopic parallaxes of 27 stars of large proper motion are found to be in good agreement with the measured values. The measured parallaxes range from $+0''.02$ to $+0''.27$, and the spectroscopic results show an average deviation of $0''.026$.

Determinations of radial velocity at Mount Wilson have yielded a total of 48 stars with radial velocities, corrected for the Sun's motion, exceeding 50 km. The spectral types of these stars are as follows: A, 7; F, 7; G, 18; K, 9; M, 7. The stars with the very highest velocities are found in the first three types. Nearly all of the A type stars in this list are peculiar in that the characteristic magnesium line at λ 4481 is absent or very faint. It seems probable that this is related to the low absolute magnitude of these stars. The ninth magnitude star BD $+18^{\circ}3423$ of type A9 has a radial velocity of -240km. The cluster variable *XZ Cygni* has a velocity of -150 km with a moderate variation. Its spectrum varies from about A0 at maximum to A8 at minimum.

The spectroscopic binary Boss 46 has a composite spectrum both components showing the helium lines. The maximum separation so far observed is about 400 km, with the H and K lines showing little or no variation. The period is probably of the order of two days and is under investigation.

ON THE CALIBRATION OF THE PHOTOMETER WEDGE OF THE LEANDER McCORMICK OBSERVATORY

By Harold L. Alden.

The calibration curve of the photometer wedge of the McCormick Observatory derived from recent measures, (1914-16), shows an undoubted change from that obtained from the earlier data, (1900-1905). The maximum amount of the change is less than a quarter of a magnitude, the difference being mainly in the thinner portions of the wedge. This change is in the direction that would be produced by a deterioration of the photographic film. It is probably due partly to this, and partly to changes in the adjustments of the photometer.

A SMALL STAR WITH THE LARGEST KNOWN PROPER MOTION.

By E. E. Barnard.

As the title implies the paper deals with the discovery of a star of the eleventh (photographic) magnitude with a proper motion of $10''.3$ a year. Visually the star is of about the tenth magnitude. It is in the constellation of Ophiuchus and follows the star BD $+ 4^{\circ}3560$ by about 9^{s} and is north $1'$. It is in the mean position

$$1916.423 \quad \alpha = 17^{h}\ 53^{m}\ 43^{s}.60 \quad \delta = +4^{\circ}\ 27'\ 48''.0$$

Adams, at the Mount Wilson Solar Observatory, finds that the spectrum of the star is type Mb (H. C. O. Classification) and that the radial velocity is -93 km. He also finds from its spectrum that its parallax is $+ 0''.2$.

THE INTERRELATION OF THE ASTEROID ELEMENTS.

By Samuel G. Barton.

Lantern slides were exhibited showing the variations in the average value of each other element as the 806 asteroids are arranged in small groups with each element in turn increasing. The effects of the secular perturbations of the orbits by Jupiter appear. There are 47 asteroids which have mean daily motions between 1025″ and 1119″ and everyone has an inclination under 6°.8 whereas the average inclination of all is 9°.6. The mean daily motion is very large for asteroids with inclinations of 5°. The mean daily motion and the eccentricity increase with increasing inclination. The asteroids are about uniformly distributed as to size.

NOTE ON ROTATION PERIODS OF PLANETS.

By L. A. Bauer.

The question as to the possible existence of cosmical effects arising from planetary magnetic fields is engaging the attention, at present, of various investigators. The first step is to determine, if possible, the relative strengths of the magnetic fields supposed to envelop the members of our solar system. Assuming that the magnetic fields result from the fact that the bodies which they envelope rotate about certain axes, the author has deduced a theoretical formula* which yields for example, a value for the magnetic field strength of the Sun agreeing within 10 per cent of Hale's observed, provisional value. The formula involves the following quantities: ω, the angular velocity of rotation; r, the mean radius of the body; d, the mean density, or, instead of the latter, g, gravity at the surface. These quantities being known, the formula gives the magnetic field strength of a planet relative to that of the Earth, a known quantity. It is thus seen that the question of the rotation periods of planets, as also the direction of rotation, is one of interest to the student of cosmical magnetism. Unfortunately only in the case of half of the planets, namely, the Earth, Mars, Jupiter, and Saturn, is the the period of rotation definitely known.

In putting together all known facts regarding the planets, it was noticed that for the four named the product ωv, in which ω is the angular velocity of rotation and v the orbital velocity of the planet, could

* See *Phys. Rev.*, Ser. 2, Vol. 7, p. 500, 1916; the paper containing the formula was given at the New York meeting of the American Physical Society, February 26, 1916.

be regarded as a constant quantity within about fifteen per cent of its mean value. Thus taking ωv as unity for the Earth, we have for Mars, 0.80, for Jupiter 1.05, and for Saturn 0.76; the mean value for the four planets is at present 0.90.

ON THE PROGRESS OF THE NEW LUNAR TABLES.

By Ernest W. Brown.

It was stated that over 400 pages of the tables were already printed off and that it was hoped that the printing might be completed within the ensuing twelve months. It is expected that the ephemeris for the year 1923 will be completed in time for its insertion in the Almanacs of that year. Some details concerning the presswork, the use of the tables, and the cost of the undertaking were also communicated to the Society.

DETERMINATION OF WAVE LENGTHS BY INTERFERENCE.

Keivin Burns, W. F. Meggers, P. W. Merrill.

The wave-lengths of 400 lines in the spectrum of the iron arc between the limits λ 3233 and λ 6750 have been determined at the Bureau of Standards by interference methods. The accuracy attained is about one part in 2,000,000 or 0.001 Å to 0.004 Å. In most parts of the region there is a line so determined every 10 to 15Å. The fineness of lines as determined from the highest order of interference which they will stand, has been compared with their pole effect displacements with interesting results. These data on the iron lines have been published in Scientific Paper No. 274 of the Bureau of Standards.

Astronomers have been interested in the rare gases as possibly furnishing convenient comparison spectra, particularly in the red region. Wave-lengths in these spectra are being measured by interference at the Bureau of Standards. Three red lines have been measured in the helium spectrum; numerous lines in the neon spectrum from λ 5852 to λ 7245; in the argon (red) spectrum from λ 6965 to λ 8440. These long wave-lengths are easily reached by treating ordinary photographic plates with dicyanin. In a preliminary survey in the first order of a twenty-one foot grating Mr. Meggers has photographed numerous lines in metallic spectra between λ 8000 and λ 9600.

CO-OPERATION IN VARIABLE STAR OBSERVING.

By Leon Campbell.

The study of variable stars has, for nearly a century, proved a large and fruitful field for research. Numerous determinations of their light have been made by visual estimates, especially so by the step-method perfected by Argelander and the method of direct estimates later adopted at Harvard. This has proved particularly applicable to the variables of long period and large range, while photometric methods have generally supplanted it in the case of the short periods and those of small range.

Observations of a large number of long period variables have been made at the Harvard Observatory for more than twenty-five years, and from time to time, a number of amateur and semi-professional observers have greatly aided in the work. For some years past the Variable Star Section of the British Astronomical Association has been conducting an earnest campaign along the same line and has secured valuable results for about 30 of these stars, on the Harvard scale of magnitudes, and more recently their list has been extended to include about 50 stars. They have already published 20,000 observations and have about 16,000 more in preparation for printing. The Harvard Observatory has published to date some 49,000 and is preparing to print about 15,000 more, secured in the past five years by the regular staff and coöperating outsiders.

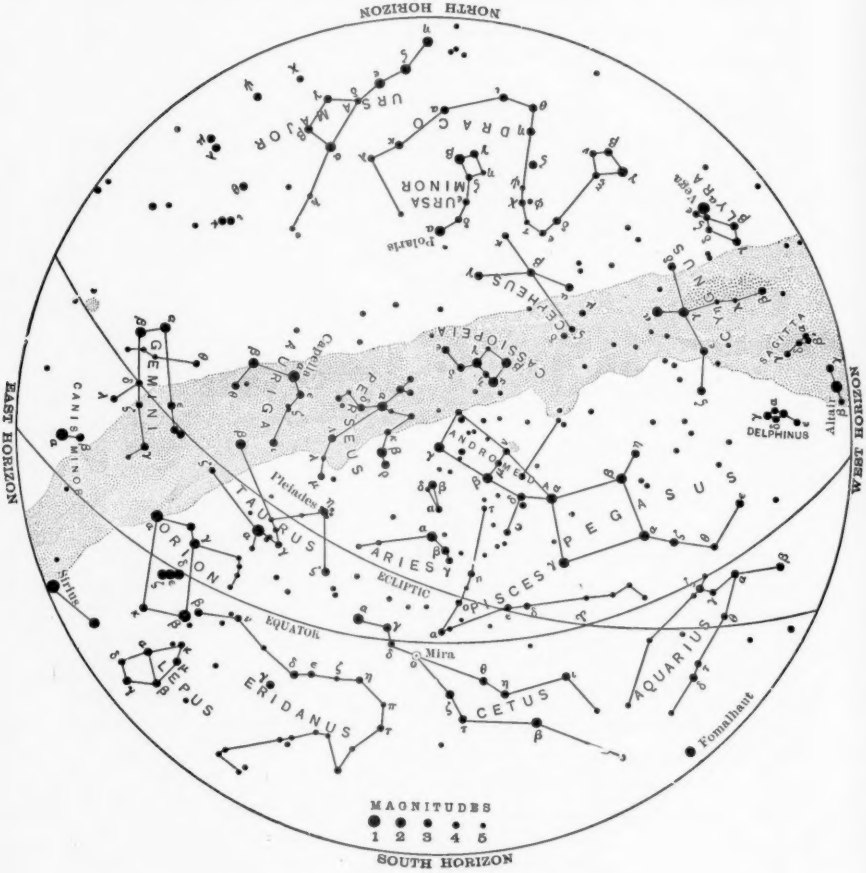
The formation of the American Association of Variable Star Observers in 1911 added another source of aid in this work, and already they have made a splendid record. About 58,000 observations have been obtained through their efforts and all of these have been published in the monthly issues of Popular Astronomy. Thus we have available for the discussion of about 300 variables something like 89,000 observations made during the past five years and the greater part of this due to our American Observers.

It seems desirable that provision should be made for the regular observation of these variables when faint, in large telescopes and that the present plan for the study of the northern variables of long period should be extended to the southern skies. This can best be accomplished by still closer coöperation on a well defined basis and, if possible, by extending to our American Variable Star Observers the support, or endorsement, of the American Astronomical Society, for it would be a pity to see it decline through lack of due appreciation by the scientific world.

(*To be continued.*)

PLANET NOTES FOR DECEMBER, 1916.

The sun will move southward until December 21, the date of the winter solstice. After this date it will move northward. Its motion among the stars is in an eastward direction moving from Scorpio into Sagittarius. It will not be near any bright star during the month. A partial eclipse of the sun will occur on December 24. It will be visible only in the regions south of Africa.



THE CONSTELLATIONS AT 9:00 P. M. DECEMBER 1.

The phases of the moon for December are as follows:

			h	m		
First Quarter	Dec.	1	at	7	55.5	P.M. C.S.T.
Full Moon		9	"	6	43.9	A.M. "
Last Quarter		17	"	12	6.4	P.M. "
New Moon		24	"	2	31.2	P.M. "
First Quarter		31	"	6	7.2	A.M. "

Mercury will move in an easterly direction and on December 31 it will be found near the eastern boundary of Sagittarius, Its distance from the sun will be gradually increasing and shortly after the middle of the month it may be seen in the early twilight.

Venus will still be in the morning sky. At the beginning of the month it may be found near the western boundary of the constellation Libra and at the end of the month near the western boundary of Ophiuchus. On December 28 it will be about 5° north of Antares. Because of its increasing distance from the earth its brightness will be constantly diminishing.

Mars will be low in the western sky setting about an hour after sunset on the 15th. It will be about as bright as Polaris and therefore not easily observed in the twilight. Its actual distance from the earth is increasing. During the month it will move eastward in the constellation of Sagittarius. On December 22 Mercury and Mars will be in conjunction.

Jupiter may be found in the eastern part of Pisces in almost the same position with regard to the stars as it occupied last June. It will be in a good position for evening observation during the entire month.

Saturn will be getting into a position for evening observation as the month progresses. It will be found in the constellation of Cancer.

Uranus may still be seen in the evening sky but it is getting too low in the west for effective observation. On December 12 it may be found near ε Capricorni.

Neptune will be found in the constellation of Cancer just a little east of Saturn Its stellar magnitude is 7.7

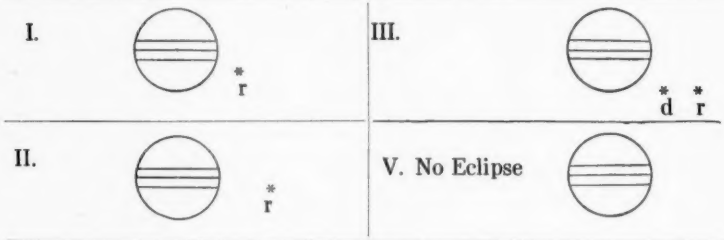
Occultations Visible at Washington.

Date 1916		Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle f'm N.	EMERSION. Washington M.T.		Angle f'm N.	Duration	
				h	m	°	h	m	°	h	m
Dec.	2	22 B Piscium	6.4	3	4	13	3	53	282	0	50
	2	16 Piscium	5.7	11	32	98	12	20	209	0	49
	5	47 B Arietis	6.5	11	53	72	13	8	282	1	15
	6	ε Arietis(Mean)	4.6	10	55	136	11	34	190	0	39
	7	27 Tauri	3.7	8	9	10	8	48	310	0	39
	7	36 Tauri	5.6	16	46	124	17	34	236	0	47
	8	k Tauri	5.6	16	35	174	16	49	199	0	14
	11	149 B Gemin.	6.4	9	2	166	9	36	207	0	24
	11	79 Gemin.	6.3	20	31	80	21	17	320	0	47
	14	83 B Leonis	5.9	14	42	102	16	3	330	1	21
	14	89 B Leonis	6.2	16	51	161	8	3	274	1	12
	14	π Leonis	4.9	18	22	136	19	39	295	1	17
	16	e Leonis	5.1	20	54	191	21	22	235	0	29
	18	370 B Virginis	6.0	13	43	82	14	32	338	0	49
	26	π Capricorni	5.2	3	35	34	6	28	270	0	54
	27	18 Aquarii	5.5	5	19	343	5	39	310	0	20

Satellites of Jupiter, December, 1916.

GREENWICH MEAN TIME.

Phases of the Eclipses of the Satellites for an Inverting Telescope.



Configurations at 14h 10m for an Inverting Telescope.

Day	West	East
1	·4 ○ 1·2· ·3	
2	·4 2· ·1 ○ ·3	
3	·2·4 ○·1 3·	
4	3· ○ ·4 ·2	·1●
5	3· 1·2○· ·4	
6	·3 ·2 ○ ·1 4·	
7	1· ·3 ○·2 ·4	
8	○ 1· ²:₃ 4·	
9	²:₁ ○ ·3 4·	
10	·2 ○ 1· ·3 4·	
11	³·○₁ 4· ·2	
12	○1· 3· 4· ○ 2·	
13	·34· 2· ○ ·1	
14	4· ¹:₃ ○	·2●
15	4. ○ ·1·32·	
16	·4 ·12· ○ ·3	
17	·4 ·2 ○ 1· 3.	
18	○3. ·4 ·1○ ·2	
19	○1· 3· ·4 ○ 2·	
20	·3 2· ○ ·4	1●
21	·3 1· ·○2 4.	
22	○ ·1 ·3 4·	
23	1· 2· ○ ·3 ·4	
24	·2 ○ 1· ·3 ·4	
25	·1 ○ 3· ·2 ·4	
26	·3 ○1· 2· 4·	
27	·3 2· ○ 4·	·1●
28	3. ¹·○ 4· ·2	
29	4· ○ .1 ·2	·3●
30	○2· 4· 1· ○ 3·	
31	4· ·2 ○ 1· ·3	

Phenomena of Jupiter's Satellites.

[Visible at Washington.]

CENTRAL STANDARD TIME.

		h	m				h	m		
Dec.	2	12	34	I	Oc, D.	16	5	40	II	Sh. E.
	3	9	44	I	Tr. I.	18	7	40	III	Tr. I.
		10	41	I	Sh. I.		9	29	III	Tr. E.
		11	53	I	Tr. E.		10	40	I	Oc. D.
		12	50	I	Sh. E.		12	31	III	Sh. I.
	4	4	27	III	Sh. I.	19	7	50	I	Tr. I.
		6	10	III	Sh. E.		9	0	I	Sh. I.
		7	1	I	Oc. D.		9	59	I	Tr. E.
		10	10	I	Ec. R.		11	9	I	Sh. E.
	5	5	10	I	Sh. I.	20	5	8	I	Oc, D.
		6	20	I	Tr. E.		8	31	I	Ec. R.
		7	19	I	Sh. E.	21	4	27	I	Tr. E.
		9	8	II	Tr, I.		5	38	I	Sh, E.
		11	9	II	Sh, I.		8	12	II	Oc. D.
		11	41	II	Tr. E.	23	5	45	II	Sh, I.
		13	42	II	Sh. E,		5	50	II	Tr, E.
	6	4	39	I	Ec, R,		8	18	II	Sh. E.
	7	7	58	II	Ec. R.	25	11	23	III	Tr. I.
	10	11	33	I	Tr. I.	26	9	41	I	Tr, I.
		12	36	I	Sh, I.		10	56	I	Sh, I.
		13	42	I	Tr. E.		11	51	I	Tr. E.
	11	5	48	III	Tr. E,	27	7	0	I	Oc. D.
		8	29	III	Sh, I.		10	27	I	Ec, R.
		8	50	I	Oc, D.	28	5	25	I	Sh. I.
		10	11	III	Sh, E.		6	19	I	Tr, E.
		12	6	I	Ec, R.		7	33	I	Sh, E.
	12	6	0	I	Tr. I.		10	41	II	Oc. D.
		7	5	I	Sh. I,	29	4	56	I	Ec. R.
		8	9	I	Tr. E.		6	31	III	Ec. D
		9	14	I	Sh. E		8	14	III	Ec. R.
		11	33	II	Tr. I.	30	5	47	II	Tr. I.
	13	6	35	I	Ec. R.		8	22	II	Tr, E.
	14	5	46	II	Oc. D,		8	25	II	Sh, I.
		10	35	II	Ec, R.		10	45	II	Sh. E.

Note:—I., denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

JUPITER—RISING.

When shadows of evening shroud hillside and plain,
And suns of the night glitter bright overhead,
Then, softly a planet is shining again,
Like satellite rising from Earth's eastern bed;

So golden and gorgeous, so placid and clear,
Grand Jupiter gleams in the light of the Sun,
When early frost comes like a blight far and near
And slowly October's leaves fall one by one.

CHARLES NEVERS HOLMES.

Newton, Mass.
41 Arlington St.

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by Agnes E. Wells at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1916 December
	h m	° ′		d h	d h; d h; d h; d h; d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	19 11
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	4 19; 12 11; 20 3; 27 19
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	4 4; 11 15; 19 1; 26 11
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	1 19; 9 7; 24 6; 31 17
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	7 16; 13 19; 19 22; 26 0
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	6 19; 13 23; 21 2; 28 5
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	4 9; 11 6; 18 2; 26 23
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	3 18; 10 22; 18 2; 25 6
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	5 17; 4 12; 23 7
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	6 20; 14 19; 22 17; 30 16
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	29 11
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 11; 11 4; 22 16; 28 9
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	1 1; 7 20; 21 11; 28 6
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	8 10; 16 7; 24 4
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	7 0; 15 7; 23 15; 31 22
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	5 0; 12 21; 20 19; 28 16
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	8 0; 21 5
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	3 22; 13 9; 22 19
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	3 20; 16 6; 28 16
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	6 22; 13 14; 20 6; 26 22
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	1 1; 11 23; 22 21; 28 7
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	3 13; 9 14; 21 15; 27 15
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	7 16; 16 7; 24 23
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	1 21; 12 7; 22 17
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	4 22; 12 22; 20 22; 28 23
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	1 17; 13 4; 24 15; 30 8
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	2 15; 13 19; 25 0; 30 15
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	3 23; 12 3; 20 8; 28 13
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	5 2; 12 17; 20 8; 27 23
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	7 5; 19 10
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	2 1; 9 5; 16 9; 30 17
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	3 10; 12 12; 21 17; 30 16
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	7 10; 16 17; 26 0
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	17 3; 27 1; 36 22
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	2 20; 11 5; 19 5; 28 0
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	3 5; 9 16; 22 12; 28 23
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	4 18; 12 0; 19 7; 26 13
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	2 6; 10 9; 18 12; 26 15
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	4 19; 14 7; 23 18
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	4 5; 13 8; 22 11; 31 14
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	5 23; 11 21; 23 18; 29 16
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	1 6; 9 17; 18 3; 26 13
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	7 18; 17 0; 26 7
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	6 7; 12 22; 19 12; 26 3
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	5 10; 14 5; 23 0; 13 19
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	2 13; 9 20; 17 4; 24 12
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	7 7; 14 1; 20 20; 27 15
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	1 10; 8 22; 16 10; 23 22
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.2	1 10; 11 0; 20 14; 30 4
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	6 3; 13 13; 21 0; 28 10
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	6 14; 13 13; 20 13; 27 12

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1916 December
	h m	° ′		d h	d h d h d h d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	3 8; 10 6; 24 1; 30 23
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	7 1; 15 11; 23 21
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	2 23; 10 15; 18 7; 25 22
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	3 13; 10 21; 18 5; 25 13
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	3 7; 11 13; 19 19; 28 1
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	4 18; 13 14; 22 11; 31 7
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	6 3; 17 5; 26 21
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	4 20; 11 16; 18 11; 25 6
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	8 23; 27 6; 23 15
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	6 13; 12 16; 18 20; 31 3
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	4 7; 11 12; 18 17; 25 22
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	8 9; 15 18; 23 3; 30 12
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	5 2; 13 7; 21 11; 29 15
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	2 23; 10 11; 18 0; 25 13
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	4 6; 12 0; 19 18; 27 12
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	5 12; 13 15; 21 14; 29 14
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	1 19; 10 7; 18 20; 27 8
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	1 8; 10 16; 20 0; 29 9
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	7 23; 18 7; 28 15
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	6 21; 14 3; 21 9; 28 15
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	7 18; 14 16; 21 14; 28 12
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	15 3; 30 6
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	4 18; 13 0; 21 6; 29 13
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	2 15; 11 12; 20 10; 29 7
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	7 0; 15 7; 23 15; 31 22
RR Draconis	40.8	+62 34	9.3—13	2 19.9	7 8; 15 20; 24 8
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	6 3; 12 18; 19 10; 26 6
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	7 10; 20 8
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	3 1; 12 14; 22 3
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	1 19; 9 8; 16 22; 24 12
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	2 16; 9 22; 24 6; 31 11
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	8 6; 17 5; 26 4
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	6 1; 12 19; 19 13; 26 8
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	6 6; 13 15; 20 23; 28 8
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	3 8; 8 14; 19 1; 24 7
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 3; 8 15; 21 16; 28 5
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	6 17; 12 17; 24 18; 30 18
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	3 10; 10 2; 16 17; 29 23
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	1 7; 10 10; 19 14; 28 17
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	6 12; 14 22; 23 8; 31 19
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	6 0; 12 19; 19 14; 26 9
UW Cygni	19.6	+42 55	10.5—10.8	3 13	7 21; 13 23; 20 20; 27 18
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	12 18
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	3 22; 13 13; 23 4
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	2 13; 11 18; 20 22; 30 3
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	3 7; 10 9; 18 7; 25 18
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	4 0; 9 20; 21 13; 27 9
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	8 12; 18 14; 28 16
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	1 13; 8 22; 23 16; 31 2
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	1 18; 11 10; 21 3; 30 19
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	5 22; 13 19; 21 16; 29 13
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	23 23
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	1 21; 12 1; 22 4
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	5 4; 10 8; 20 17; 25 22
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	2 18; 13 16; 24 13; 30 0
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	7 14; 15 21; 24 4
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	8 4; 15 17; 23 5; 30 18
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	3 10; 11 15; 19 21; 28 3

Maxima of Variable Stars of Short Period.

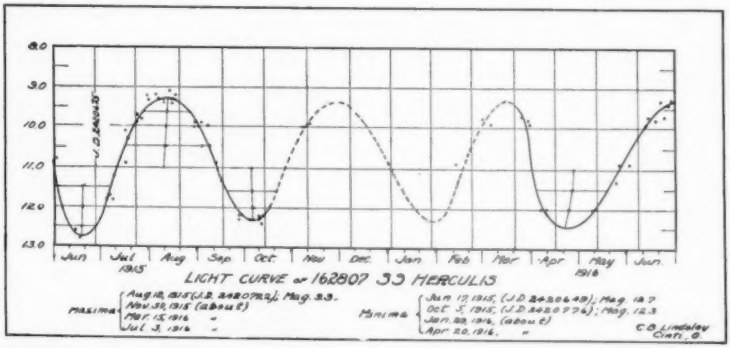
[Calculated by Bertha Booth and Bessie Burnham at Goodsell Observatory.]

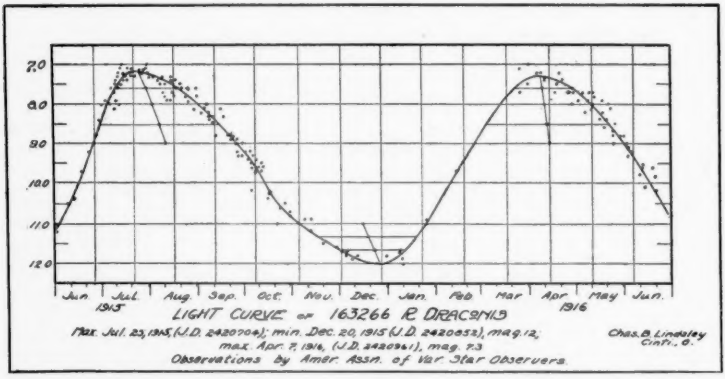
Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1916. December							
	h m	° ′		d h	d	h	d	h	d	h	d	h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	5	3						
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	2	2;	10	5;	18	9;	26	10
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	3	4;	10	22;	18	16;	26	10
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	8	12;	23	7				
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	4	21;	12	20;	20	18;	28	17
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	6	19;	14	14;	22	9;	30	4
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	2	23;	10	6;	17	12;	24	19
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	3				19			
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	2	8;	10	22;	19	12;	28	2
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	4	19;	15	22;	27	1		
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0			12	12;			24	3
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	2	0;	9	16;	17	8;	24	23
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3			11	1;	21	4;	31	7
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	3	10;	11	3;	18	21;	26	14
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	6	5;	11	18;	22	19;	28	8
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	4	21;	12	11;	20	0;	27	14
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3					23	21		
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	6	7;	13	12;	20	17;	27	22
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	8	3;	16	1;	23	23;	31	21
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2	14;	12	17;	22	21		
RU Camelop.	7 10.9	+69 51	8.5— 9.8	12 06.5	7	11			29	18		
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	3	9;	11	8;	19	6;	27	5
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	1	16;	8	9;	21	18;	28	11
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	4	5;	13	11;	22	18		
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	4	2;	12	20;	21	14;	30	8
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	5	6;	12	1;	18	20;	25	14
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	4	21;	11	12;	18	2;	24	17
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	2	0;	11	16;	21	8;	30	23
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	6	23;	14	22;	22	21;	30	21
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	3	18;	10	12;	23	22;	30	16
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	3	18;	9	13;	21	5;	27	1
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	5	12;	10	5;	19	14;	28	23
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	7	15;			24	21		
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	2	0;	14	5;	18	10;	26	14
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	5	9;	12	9;	19	10;	26	10
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	7	21;	16	3;	24	6		
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	2	17;	8	5;	19	5;	30	4
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	3	7;	10	20;	18	9;	25	22
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	3	15;	11	1;	18	11;	25	21
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	5	18;	12	13;	19	9;	26	4
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	3	2;	9	10;	15	17;	28	9
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	4	19;	14	13;	24	7		
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	9	16;	18	13;	29	10		
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	5	10;	11	12;	23	15;	29	16
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	6	9;	13	9;	20	9;	27	10
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9			11	12;	28	14		
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	7	14;	15	5;	22	19;	30	9
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	4	7;	10	2;	21	15;	27	9
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	2	22;	9	16;	23	4;	29	22

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1916. December
	h m	° ′		d h	d h d h d h d h
Y Scuti	18 32.6	− 8 27	8.7— 9.2	10 08.3	3 1; 13 9; 23 18
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	3 10; 9 10; 21 12; 27 13
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	7 0; 13 3; 25 9; 31 13
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	4 13; 10 11; 22 9; 28 8
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	4 13; 13 15; 22 18; 31 20
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	6 20; 13 21; 20 22; 27 22
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	6 4; 13 4; 20 4; 27 4
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	8 18; 16 17; 24 17
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3 20; 11 13; 19 5; 26 22
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	1 20; 9 0; 23 9; 30 13
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	8 3; 16 12; 24 22
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	6 22; 13 6; 19 14; 25 21
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	3 16 20 2
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	1 14; 10 11; 19 8; 28 5
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	4 1; 10 18; 24 5; 30 23
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	3 4; 9 22; 16 15; 30 1
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	12 9; 27 3
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	6 9; 14 6; 22 3; 29 23
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	4 2; 11 0; 24 18; 31 16
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 18; 12 11; 22 5; 31 23
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	7 20; 16 12; 25 3
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	2 9; 13 3; 23 20; 29 5
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	8 8; 19 5; 30 2
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	2 12; 8 22; 21 19; 28 5
V Lacertae	22 44.5	+55 48	8.5— 9.5	4 23.6	3 0; 8 0; 17 23; 27 22
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	5 18; 10 5; 22 2; 27 12
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	7 3; 13 10; 19 17; 26 0
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	5 21; 18 1; 30 4
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.6	2 23; 12 21; 22 21; 27 20

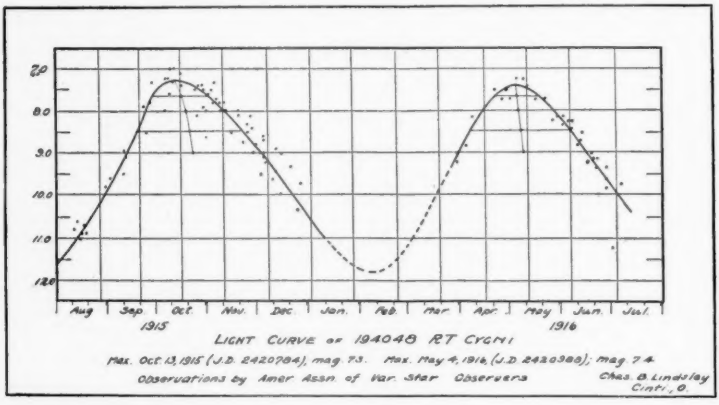




LIGHT CURVE OF 163266 R. DRACONIS

Max. Jul. 23, 1915, (J.D. 2420704); min. Dec. 20, 1915 (J.D. 2420852), mag. 12;
max. Apr. 7, 1916, (J.D. 2420961), mag. 7.3
Observations by Amer. Assn. of Var. Star Observers.

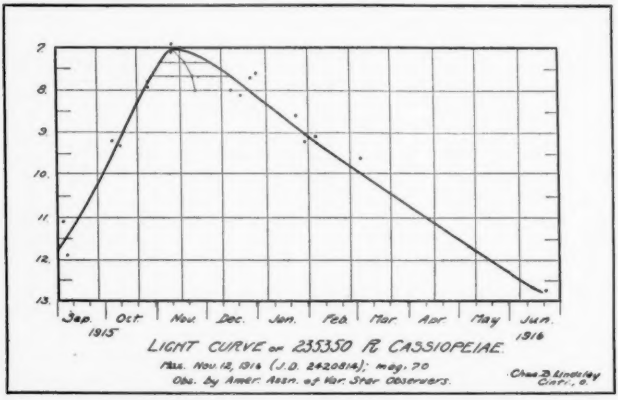
Chas. B. Lindsley
Cintr., O.



LIGHT CURVE OF 194048 R.T. CYGNI

Max. Oct. 13, 1915 (J.D. 2420784), mag. 7.3. Max. May 4, 1916, (J.D. 2420988); mag. 7.4
Observations by Amer. Assn. of Var. Star Observers.

Chas. B. Lindsley
Cintr., O.



LIGHT CURVE OF 235350 R. CASSIOPEIAE.

Max. Nov. 12, 1916 (J.D. 2420814); mag. 7.0
Obs. by Amer. Assn. of Var. Star Observers.

Chas. B. Lindsley
Cintr., O.

COMET AND ASTEROID NOTES.

Ephemeris of Comet *b* 1916 (Wolf).—The following ephemeris is taken from the *Lick Observatory Bulletin*, No. 286, and was computed by Professor R. T. Crawford of the Berkeley Astronomical Department. It will be remembered that this comet was discovered when far out in its orbit, near the path of Jupiter, and that the elements derived from the observations in April and May indicated that it would not reach perihelion until June 1917. The last available observation, that of Barnard on July 5, was represented by the elements within the errors $+0^s.3$ and $-1''$, in right ascension and declination respectively.

After having passed conjunction with the sun the comet will be in position for observation in December of this year. From then on until next May its position will become more favorable and the comet will continually increase in brightness.

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

1916 G. M. T.	True α	True δ	log Δ	Br.
	h m s	° ′ ″		
Nov. 29.5	15 06 47.9	−5 07 13	0.5862	2.96
30.5	08 25.9	10 18		
Dec. 1.5	10 04.4	13 19	0.5829	3.04
2.5	11 43.3	16 16		
3.5	13 22.6	19 08	0.5794	3.13
4.5	15 02.4	21 56		
5.5	16 42.6	24 40	0.5760	3.22
6.5	18 23.2	27 20		
7.5	20 04.3	29 55	0.5724	3.32
8.5	21 45.8	32 25		
9.5	23 27.8	34 51	0.5687	3.42
19.5	25 10.2	37 11		
11.5	26 53.1	39 27	0.5650	3.52
12.5	28 36.4	41 38		
13.5	30 20.2	43 43	0.5612	3.63
14.5	32 04.4	45 43		
15.5	33 49.0	47 38	0.5574	3.74
16.5	35 34.1	49 27		
17.5	37 19.7	51 11	0.5534	3.86
18.5	39 05.7	52 49		
10.5	40 52.2	54 22	0.5494	3.98
20.5	42 39.1	55 49		
21.5	44 26.5	57 10	0.5453	4.11
22.5	46 14.3	58 25		
23.5	48 02.5	−5 59 33	0.5411	4.25
24.5	49 51.2	−6 00 35		
25.5	51 40.3	01 31	0.5369	4.39
26.5	53 29.9	02 21		
27.5	55 19.9	03 04	0.5326	4.54
28.5	57 10.3	03 40		
29.5	15 59 01.2	04 10	0.5282	4.70
30.5	16 00 52.5	04 33		
Dec. 31.5	16 02 44.3	−6 04 49	0.5237	4.86

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, September-October, 1916.

This month's report is in many respects the most excellent the Association has submitted, and a fitting close for our fiscal year. During the past month 232 variable stars were observed, which breaks our monthly record, which heretofore has been 196 variables.

The weather was remarkably fine during September and exceptionally meritorious lists were contributed by Messrs. Bancroft, Bouton, Burbeck, and McAteer.

We welcome as a new member of the Association this month Mr. C. R. Rogers, "Ro" of Minneapolis, Minn.

Lists of observations were receivcd from Messrs. de Perrot, Lacchini, and Yendell, too late for publication in last month's report and are included herewith.

A most enjoyable event for those participating was a week-end spent at the home of Mr. J. J. Crane, in Sandwich, Mass. Mr. Campbell, Mr. Burbeck and the Secretary had this pleasure, and two fine nights were spent to good advantage in Mr. Crane's well equipped observatory.

The feature of chief interest and importance in this report is the observed anomalous maximum of the Variable 213843 SS Cygni. The average interval between the last three maxima has been thirty-five days, much shorter than is usual. The rise was observed by many of our members. On one night ten observers had it under inspection, and on September 30 a drop of .5 of a magnitude in one hour was observed, which is extraordinary even in the case of this erratic and enigmatic star.

The following calculated dates of maxima are cited from the "Companion to the Observatory."

Nov.	4	012502	R Piscium	Nov.	26	013133 R Trianguli
	15	190108	R Aquilae		28	*204405* T Aquarii

Mr. Bancroft calls attention to an error in Klein's Star Atlas, the position of the Variable 045307 R Orionis being incorrectly indicated.

The following members of the Association were honored with an election to membership in the American Astronomical Society at the recent meeting at Swarthmore, Pa.: Messrs. Bancroft, Burbeck, Gray, Lindsley, and D. B. Pickering.

A meeting of our Association will be held in Cambridge, Mass., Saturday November 18. Professor E. C. Pickering, Director of the Harvard College Observatory, has graciously offered to entertain us on that occasion. This is an exceptional opportunity for our members to meet together in the happy fellowship of kindred spirits that insures a red-letter occasion, and it is hoped that we will have a large attendance. A special appeal is made to distant members to attend this meeting. Members who expect to be present at the meeting are requested to notify the Secretary fully two weeks in advance of the date of the meeting.

The annual report of the Association is included in this report and contains the individual records for the year. A record of nearly 60000 observations in five years work well attests the value of coöperation, and is a highly creditable result.

During the past year we have maintained a membership of thirty observers, greatly increased the scope of our work, and beyond question the quality of the observations is approaching a state of excellence that will soon render them authoritative.

VARIABLE STAR OBSERVATIONS September-October, 1916.

001032
S Sculptoris

J.D. 242	Est.	Obs.
1134.7	11.4	Ba

001046
X Androm.

1113.6<12.0		Bu
26.6	13.6	B
26.6<13.2		Ba

001726
T Androm.

1109.6	9.5	O
10.7	9.4	Ly
11.6	9.5	M
15.7	9.8	Ly
26.6	11.1	Ba
27.6	11.2	Bu
28.7	10.9±V	
32.6	11.3	Pi
32.6<10.7		S
33.6	11.5	Bu

001755
T Cassiop.

1109.6	9.8	M
11.5	9.2	O
16.6	9.1	B
21.5	9.4	O
26.6	9.2	Ba
27.6	9.8	Bu
28.6	9.4	Pi
32.5	10.5	O
32.6	10.0	S

001838
R Androm.

1066.4	7.3	Pe
67.4	7.5	Pe
70.4	7.6	Pe
74.4	7.7	Pe
75.4	7.7	Pe
76.4	7.8	Pe
77.4	7.8	Pe
80.4	7.9	Pe
81.4	7.9	Pe
96.4	8.4	Pe
97.4	8.5	Pe
1110.6	9.2	Cr
11.5	8.8	O
11.6	9.1	M
13	9.1	T
13.6	9.1	Cr
14	9.1	T
18.6	8.9	B
26.6	9.1	Ba
27.6	9.8	Bu
28.5	9.2	O
28.7	9.3	V
31	9.1	T
32.6	9.5	Pi
33.6	9.7	Hu
35.5	10.0	O
39.5	10.3	O

001909
S Ceti

J.D. 242	Est.	Obs.
1116.7	9.3	M
26.6	9.0	Ba
32.7	8.5	Pi
33.7	9.1	Ba
37.6	8.5	M
37.6	8.4	S

003179
Y Cephei

1125.6	11.0	Hu
26.6	11.0	Ba
33.7	12.4	Bu

004047
U Cassiop.

1077.4	10.1	L
98.4	9.9	L
1111.6	10.5	B
14.6	10.6	M
22.6	10.7	M
26.6	10.9	Ba
27.7	10.6	Bu
32.6	<9.9	S
33.7	10.8	Bu
35.5	10.0	Wh

004132
RW Androm.

1111.6	7.8	M
16.6	7.5	O
16.6	7.6	Cr
16.6	7.6	Bu
20.6	8.0	B
26.6	8.1	Ba
27.6	8.1	Bu
28.5	8.1	O
32.5	8.2	O
32.6	8.1	Pi
33.7	8.3	Bu
35.5	8.2	O
39.5	8.6	O
42.5	8.7	O

004435
V Androm.

1109.6	9.3	Bu
10.7	9.2	Ly
12.6	9.7	M
15.7	9.2	Ly
16.6	9.6	O
16.6	9.5	Cr
20.6	9.3	B
22.7	9.3	Ly
26.6	9.7	Ba
28.5	9.8	O
32.5	10.0	O
32.6	10.3	Hu
32.6	10.1	Pi
33.7	9.0	Bu
35.5	10.2	O
39.5	10.4	O

004533
RR Androm.

J.D. 242	Est.	Obs.
1109.5	9.2	Nt
11.6	9.5	M
16.6	9.2	O
16.6	9.4	Cr
16.6	9.2	Bu
24.6	9.4	Cr
26.6	9.0	Ba
28.5	9.4	O
32.5	9.4	O
33.6	9.2	Hu
33.7	8.8	Bu
35.5	9.5	O
39.5	9.4	O
42.5	9.6	O

004746
RV Cassiop.

1098.4	9.6	L
1122.6	10.2	M
26.6	9.6	Ba
33.5	10.6	O
33.7	10.2	Bu
35.5	10.6	Wh
39.5	10.7	O

004958
W Cassiop.

1098.4	9.4	L
1109.6	9.3	M
16.6	8.5	B
26.6	9.0	Ba
32.5	9.7	O
33.7	10.2	Bu
37.5	10.0	O

010102
Z Ceti

1126.6	9.0	Ba

010940
U Androm.

1126.6	12.1	Ba
32.5	11.9	Pi
33.7<12.6		Bu

011208
S Piscium

1109.7<12.4		Bu
26.6	13.0	Ba

011272
S Cassiop.

1118.6	11.4	Bu
26.6	10.0	Ba
27.6	9.7	B
33.6	9.8	M
33.7	11.0	Bu
37.5	9.4	O
39.5	9.5	O

011712
U Piscium

J.D. 242	Est.	Obs.
1126.6<13.0		Ba

012350
RZ Persei

1109.7	10.7	Bu
1116.7<11.0		M
26.6	12.0	Ba

012502
R Piscium

1109.7	10.8	Bu
26.6	8.9	Ba
37.6	8.0	S

013238
RU Androm.

1109.7<12.1		Bu
26.6<13.0		Ba
32.5<12.1		Pi

013338
Y Androm.

1109.7<12.4		Bu
26.6<13.0		Ba
32.5<13.0		Ba

014958
X Cassiop.

1109.6	12.0	Nt
09.6	11.8	M
09.7	11.5	Bu
26.6	12.0	Ba

015354
U Persei

1109.7	8.4	Bu
1116.6	8.5	B
16.7	8.5	M
26.6	8.1	Ba
28.7	8.1	V
35.6	8.0	Pi
35.6	7.2	Wpi

015912
S Arietis

1109.7<12.5		Bu
1126.7<13.8		Ba
32.6<13.8		B

021024
R Arietis

1098.4	8.8	Pe
1106.7	8.5	Pi
09.7	8.2	Bu
26.7	7.5	Ba
32.6	8.5	M
34.6	8.0	Pi
37.6	8.0	S

021143
W Androm.

1126.7	12.7	Ba

021403
o Ceti

J.D. 242	Est.	Obs.
1081.6	8.5	L
83.6	8.6	L
1102.6	8.4	L
06.7	8.2	Pi
16.6	7.6	Bu
16.6	7.7	Cr
16.6	7.5	O
16.7	7.8	M
26.7	6.9	Ba
27.7	7.4	Bu
31.8	7.1	Mu
32	7.5	T
32.7	7.0	Pi
34.8	6.8	Mu
37.7	6.5	M

021558
S Persei

1116.6	9.3	B
16.7	9.7	M
26.7	9.3	Ba

022000
R Ceti

1126.7	12.0	Ba

022813
U Ceti

1126.7	12.0	Ba
32.7	11.8	Pi
37.7<11.0		M

023133
R Triang.

1126.7	10.5	Ba
27	9.9	T
27.7	9.9	B
28	9.9	T
31	10.3	T
32	10.0	T
35	9.9	T
37	10.0	T

024356
W Persei

1077.4	9.0	L
98.4	9.2	L
1110.7	9.0	Ly
16.7	9.1	M
23.6	8.9	Ba
26.7	9.0	Ba
30.7	9.6	Pi
35.6	9.6	Pi
35.6	9.4	Wpi

030514
U Arietis

1126.7<13.1		Ba

031401
X Ceti

1132.7	10.0	Pi
32.7	10.2	Ba

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032043
Y Persei
J.D. Est.Obs
242
1109.4 10.0 L
16.7 10.1 M
26.7 9.8 B
26.7 9.9 Ba
30.7 10.2 Pi

032335
R Persei
1126.7<12.5 Sp
30.7<11.1 Pi

033362
U Camelop.
1126.7 7.2 Ba
33.7 8.4 M

035124
T Eridani
1132.8 8.1 Ba

035915
V Eridani
1132.7 9.1 Ba

041619
T Tauri
1131.9 10.2 M

042209
R Tauri
1131.9<10.8 M
32.7<12.9 Ba
32.8<11.5 Pi

042215
W Tauri
1081.6<11.4 L
1100.6<11.4 L
26.7 11.0 Ba
30.7 10.9 Pi
31.9 10.7 M

042309
S Tauri
1131.9<10.8 M
32.7<12.9 Ba
32.8 11.5 Pi

043065
T Camelop.
1126.7 11.9 Ba
33.7 12.2 M

043208
RX Tauri
1132.7<12.1 Ba
32.8 12.3 Pi

043274
X Camelop.
1077.4 8.1 L
83.6 7.9 L
98.4 8.1 L

X Camelop.
J.D. Est.Obs.
242
1106.7 8.3 Pi
09.6 8.2 O
09.6 8.5 Cr
10.6 8.4 O
10.6 8.3 Cr
16.6 9.0 O
16.6 8.9 Cr
16.6 9.1 Bu
17.6 8.9 O
17.6 9.1 Cr
17.6 9.1 Bu
20.5 9.0 O
20.6 9.0 Ba
21.5 9.5 O
23.6 10.2 Nt
23.6 10.2 Cr
26.7 10.3 Ba
27.6 10.1 B
27.6 10.4 Cr
28.5 10.8 O
29.5 10.8 O
29.6 9.5 Bu
32.5 11.1 O
33.7 11.2 M
37.6 11.4 B

044617
V Tauri
1132.8<11.5 Pi
33.7 12.2 Ba

045307
R Orionis
1134.7 12.5 Ba

045514
R Leporis
1100.6 7.3 L
15.6 7.0 L
16.8 7.8 M
32.8 6.9 Ba

050003
V Orionis
1132.7 9.1 Ba
32.9 9.7 M

050022
T Leporis
1132.8<11.4 Ba

050953
R Aurigae
1123.8 8.7 M
26.7 8.7 Ba
32.7 8.7 Pi

052036
W Aurigae
1116.8 9.3 M
26.7<12.2 Ba
32.7<12.5 Ba
32.8 8.5 Pi

052034
S Aurigae
J.D. Est.Obs.
242
1081.6 9.1 L
1116.8 8.8 M
26.7 8.3 Ba

052405
S Orionis
1116.8 11.1 M
32.8 10.2 Ba

053005
T Orionis
1100.6 10.0 L
15.6 9.5 L
16.8 10.0 M

053006
S Camelop.
1133.7 8.5 M

053531
U Aurigae
1123.9 9.5 M
32.7 9.5 Ba

054319
SU Tauri
1132.7 9.5 Ba
34.6 9.8 Ba

054920
U Orionis
1081.6 7.4 L
31.9 8.9 M
32.7 8.8 Ba

054974
V Camelop.
1120.6<12.8 Ba
26.7<12.8 Ba
33.7<11.3 M
37.7 13.3 B

055353
Z Aurigae
1116.8 10.7 M
32.7 10.6 Ba

060450
X Aurigae
1081.6<11.9 L
1100.6<11.4 L
16.8<11.1 M
32.7 10.0 Ba

060547
SS Aurigae
1081.6<11.6 L
83.6<12.4 L
1100.6<11.6 L
02.6<11.6 L
15.6<11.6 L
16.8 10.9 M
23.8 10.6 M

SS Aurigae
J.D. Est. Obs.
242
32.7<13.0 Ba
32.8<12.4 Pi
34.7<13.3 Ba

061647
V Aurigae
1116.8 11.2 M
32.7 10.4 Ba

061702
V Monoc.
1132.8 9.9 Ba

063159
U Lyncis
1132.7 11.2 Ba

063558
S Lyncis
1132.7 10.0 Ba

064030
X Gemin.
1132.7 11.5 Be

065111
Y Monoc.
1132.8 11.7 Ba

065208
X Monoc.
1132.8 7.2 Ba

065355
R Lyncis
1132.7<12.5 Ba

065820
TW Gemin.
1123.9 8.3 M
32.7 8.5 Ba

070122a
R Gemin.
1123.9 8.5 M
32.7 8.3 Ba
32.8 8.2 Pi

070122b
Z Gemin.
1123.9<11.5 M
32.7 12.6 Ba

070310
R Can. Min.
1115.6 8.6 L
32.8 8.0 Ba

071713
V Gemin.
1132.8<12.8 Ba

072708
S Can. Min.
J.D. Est.Obs.
242
1123.9 8.7 M
32.8 8.6 Ba

072811
T Can. Min.
1123.9 10.3 M
32.8 10.2 Ba

073508
U Can. Min
1110.7<11.6 Ly
15.6<12.4 L
32.8 12.0 Ba

073723
S Gemin.
1132.8 13.0 Ba

074323
T Gemin.
1123.9 9.0 M
32.8 9.7 Pi
32.8 9.5 Ba

074922
U Gemin.
1102.6<10.0 L
32.8<12.3 Pi
32.8<13.3 Ba

083350
X Urs. Maj.
1132.8 12.5 Ba

090151
V Urs. Maj.
1081.3 10.1 L
1100.6 10.2 L
15.6 10.3 L
32.8 10.3 Ba

103769
R Urs. Maj.
1110.5 10.3 Ba
10.7 10.1 Ly
12.6 9.7 M
15.7 9.6 Ly
17. 6 8.9 O
17.6 8.8 Bu
20.5 8.5 Ba
21.6 8.8 B
22.8 8.9 Ly
23.5 8.3 Ba
23.6 8.2 M
24.6 8.1 M
25.7 8.5 Ly
26.5 8.0 Ba
27.6 7.9 M
32.5 7.9 Ba
33.6 7.7 M
36.6 7.5 M

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123160
T Urs. Maj.

J. D. 242	Est.	Obs.
1060.4	8.8	Pe
62.4	8.9	Pe
65.4	8.9	Pe
66.4	9.0	Pe
67.4	9.0	Pe
71.4	9.2	Pe
74.4	9.2	Pe
75.4	9.3	Pe
76.4	9.3	Pe
79.4	9.6	Pe
96.4	10.5	Pe
98.4	10.9	Pe
1110.6 10.7	<10.8	Pi
	11.3	Ly
15.7	11.9	Ly
20.5	11.8	Ba
22.8	<12.0	Ly
23.6	12.0	B
26.5	12.2	Ba
27.6	11.7	Nt
32.5	11.1	Wh
37.6	<10.8	M
37.6	<10.0	Bu

123307
R Virginis

1067.4	9.5	L

123459
RS Urs. Maj.

1110.6	8.7	Pi
10.6	8.7	Wpi
13.6	9.1	M
20.5	8.7	Ba
25.6	8.5	M
26.5	9.0	Ba
29.6	8.6	M
32.5	9.2	Ba
33.6	9.3	M
34.5	9.8	Wh
37.6	9.8	M

123961
S Urs. Maj.

1081.4	8.6	L
98.4	8.5	L
1109.6	8.0	M
10.5	8.0	O
10.6	8.1	Pi
10.6	8.5	Wpi
10.7	7.9	Ly
13.6	7.6	M
15.3	8.0	L
17.6	8.0	O
18.6	7.8	B
20.5	8.0	O
20.5	7.6	Ba
21.5	7.9	Cr
21.6	7.8	Bu
22.8	8.1	Ly

S Urs. Maj.

J.D. 242	Est.	Obs.
25.7	8.1	Ly
26.5	8.0	Ba
27.6	8.2	M
27.6	8.1	Nt
29.5	8.1	O
32.5	8.1	O
32.5	8.3	Wh
32.5	7.8	Ba
33.6	8.3	M
34.7	8.2	Ly
37.6	8.3	M
37.6	7.9	Cr

133273
T Urs. Min.

1113.6	10.8	Bu
20.5	11.4	Ba
26.5	11.6	Ba
27.6	11.5	M
32.5	11.7	Ba

134440
R Can. Ven.

1096.4	10.2	L
1105.4	10.2	L
10.5	9.8	Ba
13.6	9.5	Bu
18.6	9.3	B
20.5	9.4	Ba
26.5	9.0	Ba
31.6	8.7	M
32.5	8.9	Ba

140113
Z Bootis

1113.5	<11.9	Bu

141567
U Urs. Min.

1113.6	9.0	Bu
20.5	9.0	Ba
20.6	8.9	B
23.6	9.1	Pi
26.5	8.6	Ba
27.6	8.8	M
27.6	8.8	S
32.5	8.7	Ba

141954
S Bootis

1110.5	10.4	Ba
10.6	10.8	Pi
10.6	10.2	Wpi
13.6	10.7	M
13.6	9.8	Bu
18.6	11.0	B
20.5	11.3	Ba
26.5	11.5	Ba
26.5	<11.0	Wh
32.5	12.0	Ba

142539
V Bootis

J.D. 242	Est.	Obs.
1075.4	7.3	L
79.4	7.5	L
91.4	7.7	L
1105.4	8.0	L
08.7	8.0	Mu
09.4	8.0	L
10.5	7.7	Ba
10.5	8.0	O
10.6	8.0	Pi
10.6	7.7	Wpi
11.6	8.0	M
13.5	8.1	Bu
18.6	7.9	B
20.5	8.5	O
20.5	8.1	Ba
26.5	8.2	Ba
26.6	8.6	Wh
32.5	8.8	O
32.5	8.3	Ba
32.6	9.0	S

142584
R Camelop.

1098.4	11.7	L
1110.5	12.1	Ba
10.7	11.7	Ly
13.6	12.3	Bu
18.6	<12.2	B
22.8	<12.0	Ly
32.7	<11.3	Wh

143227
R Bootis

1061.4	7.8	Pe
71.4	7.5	Pe
74.4	8.2	Pe
75.4	8.1	Pe
76.4	8.2	Pe
79.4	8.6	Pe
96.4	9.0	L
1109.4	10.0	L
10.5	10.0	Ba
10.6	10.1	Pi
10.6	10.1	Wpi
11.6	8.1	M
13.5	10.2	Bu
20.5	10.9	Ba
26.5	11.3	Wh
26.5	11.4	Ba
32.5	11.7	Ba

144918
U Bootis

1109.6	10.9	B
13.5	<10.7	Bu
14.6	10.2	M
24.5	10.5	Ba

150605
Y Librae

J.D. 242	Est.	Obs.
1067.4	<12.0	L
79.4	<12.0	L
98.3	<12.0	L

151520
S Librae

1067.4	9.5	L
79.4	9.3	L
98.3	9.5	L

151714
S Serpentis

1113.6	8.4	Bu
20.5	8.7	Ba
22.6	9.2	V
26.5	9.0	Ba
29.6	9.4	M
32.5	9.3	Ba

151731
S Cor. Bor.

1074.4	11.8	Pe
75.4	11.8	Pe
76.4	11.8	Pe
1113.6	<11.2	Bu
23.6	13.0	B
24.5	<12.7	Ba
24.6	10.6	Hu

151822
RS Librae

1067.4	<11.2	L
79.4	<10.6	L

152714
RU Librae

1067.4	10.7	L
79.4	11.4	L
96.3	11.6	L

153378
S Urs. Min.

1083.6	9.9	L
1110.7	10.4	Ly
13.6	10.3	Bu
14.6	10.0	M
18.6	10.0	B
20.5	10.3	Ba
22.8	10.7	Ly
23.6	10.8	Pi
26.5	10.3	Ba
32.6	10.4	Ba
34.7	10.8	Ly

154428
R Cor. Bor.

1063.4	6.0	L
64.4	6.3	Pe
65.4	6.2	Pe
66.4	6.0	L
67.4	6.2	Pe

R Cor. Bor.

J.D. 242	Est.	Obs.
67.4	5.9	L
70.4	6.2	Pe
71.4	6.2	Pe
71.4	6.0	L
74.4	6.2	Pe
75.4	6.1	Pe
76.4	6.1	Pe
77.4	6.0	Pe
77.4	5.9	L
77.4	6.1	Pe
79.4	6.0	L
81.4	6.0	L
83.4	6.0	L
87.3	6.0	L
89.3	6.0	L
95.3	5.8	L
96.4	6.1	Pe
98.4	6.0	L
1106.6	6.0	Pi
08.7	6.0	Mu
09.3	5.9	L
09.6	6.3	Gr
09.6	5.9	Bu
09.6	6.0	Cr
09.6	6.0	O
09.7	6.1	Mu
10.5	6.0	O
10.5	6.0	Ba
10.6	6.0	Pi
10.6	6.0	Bu
10.7	6.0	Mu
11.5	6.0	O
14.6	6.0	M
15.3	6.0	L
16.6	6.0	O
16.6	6.0	Cr
16.6	5.9	Bu
17.6	6.0	O
17.6	6.0	Bu
18.6	6.0	O
18.6	6.0	Cr
20.5	6.0	O
20.5	6.0	Ba
20.6	6.0	Bu
21.3	6.0	L
21.5	6.0	O
21.6	6.0	Bu
22.6	6.0	V
23.5	6.0	Pi
23.5	6.0	Ba
23.6	6.4	Gr
23.7	6.0	Mu
24.5	6.0	Ba
24.6	6.0	O
24.6	6.0	Bu
24.6	5.6	Hu
25.7	6.1	Mu
26.5	6.0	Ba
26.6	6.2	M

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R Cor. Bor.

J.D. 242	Est.	Obs.
1126.7	6.1	Mu
27.6 >	6.0	S
27.6	6.0	Cr
27.6	6.0	Bu
28.5	6.0	O
29.5	6.0	O
29.6	6.0	Bu
30.7	6.1	Mu
31.6	6.2	M
32.5	6.0	O
32.5	6.0	Ba
32.7	6.1	Mu
33.5	6.0	Ba
33.5	6.9	Sc
33.5	6.0	O
33.6	6.0	Cr
33.6	6.0	Bu
33.7	6.1	Mu
34.5	6.0	O
35.5	6.0	O
35.5	6.0	Ba
35.7	6.2	Mu
37.5	6.0	O
37.6	6.0	Cr
39.5	6.0	O
42.5	6.0	O

154536

X Cor. Bor.

1113.6 <	12.3	Bu
26.5	12.5	Ba

154539

V Cor. Bor.

1113.6	8.4	Bu
20.5	8.3	Ba
26.5	8.2	Ba
31.6	9.7	M
32.6	8.2	Ba

154615

R Serpentis

1046.4	8.9	Pe
62.4	9.5	Pe
65.4	9.6	Pe
66.4	9.5	Pe
74.4	9.7	Pe
75.4	9.8	Pe
79.4	10.0	Pe
96.4	10.1	Pe
98.4	10.1	Pe
1106.6	11.3	Pi
09.6	11.7	B
10.7	11.9	Ly
13.6 <	10.9	Bu
15.7 <	12.0	Ly
20.5	12.2	Ba

155229

Z Cor. Bor

1113.6 <	11.1	Bu
24.5	13.2	Ba

155847

X Herculis

J.D. 242	Est.	Obs.
1108.7	5.9	Mu
09.4	6.1	L
09.5	6.7	Nt
09.7	6.0	Mu
10.5	6.5	O
10.7	6.1	Mu
11.5	6.4	O
15.4	6.2	L
17.6	6.7	Nt
20.5	6.6	O
21.5	6.5	O
23.6	6.9	Nt
23.7	6.3	Mu
25.7	6.6	Mu
26.7	6.5	Mu
28.5	6.5	O
30.7	6.5	Mu
32.5	6.8	O
32.7	6.4	Mu
33.5	5.6	Ba
33.6	7.0	Nt
33.7	6.3	Mu
35.5	6.8	O
35.7	6.5	Mu
37.5	6.6	O
39.5	6.6	O
42.5	6.5	O

160118

R Herculis

1110.5 <	13.3	Ba
13.6 <	11.4	Bu
20.5 <	13.0	Ba
32.6 <	13.4	B

160210

U Serpentis

1106.6	10.3	Pi
09.6	10.1	B
10.5	10.2	Ba
13.6	10.5	Bu
20.5	9.5	Ba
26.5	9.0	Ba
26.6	9.0	M
32.6	8.7	Ba

160625

RU Herculis

1110.6	8.1	O
10.6	8.2	Ba
13.6	8.0	Bu
14.6	8.6	M
18.6	9.0	O
20.6	8.5	B
20.6	8.5	Ba
21.6	9.3	O
22.6	8.9	V
26.5	8.4	Ba
28.5	9.6	O

RU Herculis

J.D. 242	Est.	Obs.
32.5	9.7	O
32.6	8.7	Ba
35.5	9.7	O
35.5	9.7	Pi
35.5	9.6	Wpi

161138

W Cor. Bor.

1109.6	9.3	B
10.6	9.5	O
10.6	9.2	Ba
10.7	9.4	Ly
13.6	9.4	Bu
15.7	9.7	Ly
20.6	10.0	Ba
22.8	10.1	Ly
26.5	10.8	Ba
26.6	10.7	M
32.6	11.1	Ba
33.5	10.9	O

162112

V Ophiuchi

1079.4	10.1	L
98.3	9.9	L

162119

U Herculis

1108.7	8.9	Mu
09.6	9.0	Gr
10.6	9.2	O
10.6	8.8	Ba
10.7	9.0	Ly
10.7	8.8	Mu
11.6	9.1	M
13.6	9.1	Bu
15.7	9.2	Ly
18.6	9.1	O
20.6	9.0	B
20.6	9.0	Ba
22.8	9.2	Ly
23.6	9.2	Gr
23.6	9.1	Pi
23.7	8.9	Mu
26.5	9.5	Ba
28.5	9.5	O
30.7	9.2	Mu
32.5	9.5	O
32.6	9.2	Ba
34.6	9.7	S
34.7	9.7	Ly
35.5	9.7	O
42.5	9.6	O

162542

g Herculis

1065.4	4.8	Pe

162807

SS Herculis

J.D. 242	Est.	Obs.
1066.4	9.9	L
71.4	10.2	L
77.4	10.7	L
96.4	12.4	L
1106.4 <	12.4	L
09.6 <	12.7	Nt
20.6 <	12.4	Ba
22.6 <	11.4	V
24.5	12.3	Ba
26.5	12.0	Ba
32.5	11.6	Ba
35.6	11.1	B
35.6	11.3	Ba

163172

R Urs. Min.

1114.6	10.4	M
20.6	9.2	B
20.6	9.3	Ba
23.6	9.8	Pi
26.6	9.5	Ba
27.6	10.1	M
32.6	9.6	Ba
33.6	9.8	Bu
34.5	9.6	Wh

163137

W Herculis

1124.6	11.9	Hu
24.6	13.4	Ba
33.6 <	11.6	Bu
34.6	13.5	M
35.6	13.2	B

163266

R Draconis

1106.7 <	11.0	Pi
10.6 <	11.6	Cr
10.8 <	12.0	Ly
13.6 <	12.2	Bu
15.7	11.9	Ly
21.6 <	12.2	Bu
22.8	11.7	Ly
23.6 <	12.0	Cr
24.6	11.9	Ba
24.7 <	11.0	Wh
25.7	11.3	Ly
27.6	11.8	B
27.6	11.9	Cr
32.6	11.6	Ba
33.6	11.8	Cr
33.6 <	12.2	Bu
34.6	11.8	M

164055

S Draconis

1114.6	8.7	M
20.6	9.2	Ba

S Draconis

J.D. 242	Est.	Obs.
1126.6	9.0	Ba
33.6	9.1	Ba
33.6	9.7	Bu
35.5	9.0	Pi
35.5	9.1	WPi

164715

S Herculis

1113.6	12.4	Bu
14.6	11.5	M
24.6	11.8	Ba
32.6	11.0	B
33.5	10.9	Ba
33.6	12.8	Bu
35.6	10.9	Pi
35.6	11.5	Wpi

165631

RV Herculis

1110.6	10.3	Ba
11.6	10.5	M
13.6	10.5	Bu
20.5	10.2	O
20.6	10.7	B
20.6	10.3	Ba
24.6	11.0	Hu
26.6	10.3	Ba
32.6	10.5	Ba
33.6	10.2	Bu
35.5	10.4	O
35.6	10.1	Pi
35.6	10.1	Wpi
39.5	10.9	O

170627

RT Herculis

1109.6 <	12.8	Nt
13.6 <	12.6	Bu
24.6 <	12.8	Ba
26.6 <	12.8	B
33.6 <	12.6	Bu

171333

68 *u* Herculis

1062.4	4.9	Pe
65.4	4.8	Pe

171401

Z Ophiuchi

1122.6	10.8	V
23.6	10.3	Ba
32.6	11.4	Ba

171723

RS Herculis

1108.7	11.0	Mu
10.6 <	10.1	Pi
11.6	12.2	M
13.6	12.3	Bu
18.6	11.9	B

VARIABLE STAR OBSERVATIONS September-October, 1916—Continued

RS Herculis

J.D. 242	Est.	Obs.
1123.6	12.2	Ba
23.7	<11.2	Mu
24.6	12.6	Hu
27.6	12.1	Nt
33.5	12.3	Ba
33.6	<12.6	Bu

172809

RU Ophiuchi

1124.5	<12.5	Ba
34.6	13.0	M

175111

RT Ophiuchi

1124.5	<12.7	Ba

175458

T Draconis

1112.6	9.2	M
15.6	9.9	Bu
21.6	10.9	B
22.6	10.6	V
23.6	10.8	Ba
33.6	9.5	Bu
35.5	10.3	Pi
35.5	9.8	Wpi

175519

RY Herculis

1115.6	9.4	Bu
18.6	9.7	B
20.5	9.5	O
20.6	9.6	Ba
26.6	9.8	Ba
29.5	10.2	O
32.6	10.3	Ba
33.6	9.8	Bu
35.5	10.5	O
39.5	10.8	O

180531

T Herculis

1110.6	11.2	Ba
10.7	10.9	Mu
11.6	11.4	M
15.6	11.3	Bu
20.6	11.8	B
20.6	11.7	Ba
23.5	10.2	Pi
26.6	<11.0	Cr
26.6	12.2	Ba
32.6	12.6	Ba
33.6	12.6	Bu

180565

W Draconis

1106.7	9.1	Pi
14.6	9.0	M
15.6	9.0	Bu
1120.6	8.9	B
20.6	9.0	Ba
26.6	9.0	Ba
32.6	8.9	Ba
33.6	9.3	Bu

180666

X Draconis

J.D. 242	Est.	Obs.
1114.6	<11.6	M

180931

TV Herculis

1096.4	<11.4	L
1109.3	<11.6	L

181103

RY Ophiuchi

1110.6	8.5	Ba
20.6	7.5	Ba
22.6	7.9	V
26.6	8.0	M
26.6	7.7	Ba
32.6	7.8	Ba

181136

W Lyrae

1108.7	7.7	Mu
09.6	7.6	M
09.6	7.8	Bu
10.7	7.7	Mu
18.6	8.2	O
20.6	7.8	Ba
21.6	8.0	B
23.6	8.5	Cr
23.7	8.0	Mu
24.6	7.9	Ba
24.6	8.3	Hu
24.7	8.5	Wh
28.5	8.7	O
30.6	8.6	Cr
30.7	8.5	Mu
32.5	8.8	O
32.6	8.3	Ba
32.7	8.8	Wh
33.5	8.9	O
33.6	8.7	Pi
37.6	8.8	B
37.6	9.2	Cr
37.6	9.0	Gr
39.5	8.9	O
42.5	9.2	O

182224

SV Herculis

1123.6	12.9	Ba
27.6	13.5	B
33.6	<11.9	Bu

182218

V Sagittarii

1094	8.3	T
95	8.3	T
96	8.3	T
97	8.3	T

182306

T Serpentis

J.D. 242	Est.	Obs.
1095	<11.0	T
1106	10.8	T
06.6	<10.8	Pi
09.6	9.6	T
10	9.5	T
11	9.6	T
14	9.7	T
16	9.8	T
17	9.6	T
21	9.6	T
23	<9.5	T
23.6	13.0	Ba
28	10.3	T
30	10.9	T
31	11.2	T
32	11.0	T
33	11.0	T
33.6	<12.4	Bu
34	11.3	T
35	11.3	T
37	11.5	T

182443

RW Lytae

1132.6	<13.5	B

183225

RZ Herculis

1109.6	8.7	Bu
20.6	9.4	Ba
26.6	9.5	Ba
29.6	9.8	M
32.6	9.6	Ba
37.5	10.1	O
39.5	10.3	O

183308

X Ophiuchi

1083.6	7.9	L
1109.3	6.6	L
09.6	7.0	Bu
10.8	7.0	Ly
15.7	6.8	Ly
20.6	6.8	Ba
22.7	6.7	Ly
25.6	6.8	V
25.7	6.7	Ly
26.6	6.8	M
26.6	6.6	Ba
32.6	6.6	Ba

184132

RY Lyrae

1110.6	<13.5	Ba
33.6	<12.3	Bu

184243

RW Lyrae

1110.6	<13.6	Ba
33.6	<11.8	Bu

184205

R Scuti

J.D. 242	Est.	Obs.
1062.4	6.7	Pe
64.4	6.7	Pe
65.4	6.8	Pe
66.4	6.8	Pe
66.4	6.6	L
67.4	6.9	Pe
70.4	7.0	Pe
71.4	7.0	Pe
71.4	6.9	L
74.4	7.1	Pe
75.4	7.1	Pe
76.4	7.2	Pe
77.4	7.4	Pe
77.4	6.9	L
79.4	7.3	Pe
80.4	7.3	Pe
81.4	7.2	Pe
83.4	7.1	L
87.3	7.1	L
89.4	6.5	L
92.4	6.1	L
96.4	5.9	Pe
96.4	5.6	L
97.4	5.8	Pe
98.4	5.5	L
1108.4	5.3	L
08.7	5.7	Mu
09.3	5.3	L
09.6	5.2	Bu
09.6	5.3	O
09.6	4.9	Cr
09.7	5.6	Mu
10.5	5.3	O
10.5	5.5	Ba
10.6	5.2	Pi
10.6	5.2	Bu
10.6	5.2	Cr
10.7	5.6	Mu
11.5	5.3	O
13.6	5.4	Bu
15.3	5.0	L
16.6	5.2	O
16.6	5.2	Cr
16.6	5.4	Bu
17.6	5.3	O
17.6	5.4	Bu
18.6	5.4	O
19.6	5.4	Bu
20.5	5.4	O
20.5	5.4	Ba
20.6	5.3	Cr
20.6	5.4	Bu
21.3	5.0	L
21.5	5.4	O
21.6	5.6	Bu
21.7	5.5	Mu
23.5	5.5	Ba
23.6	5.5	Pi
23.6	5.3	Cr

R Scuti

J.D. 242	Est.	Obs.
1123.7	5.5	Mu
24.5	5.5	Ba
24.6	5.4	O
24.6	5.5	Bu
24.7	5.5	Mu
25.7	5.5	Mu
26.5	5.5	Ba
26.6	5.2	M
26.7	5.5	Mu
27.6	5.4	Cr
27.6	5.6	Bu
28.5	5.8	O
29.5	5.4	O
30.6	5.8	Bu
30.7	5.5	Mu
31.8	5.5	Mu
32.5	5.7	O
32.5	5.7	Ba
32.6	5.8	Wh
32.7	5.6	Mu
33.5	5.8	O
33.5	5.7	Ba
33.6	5.6	Cr
33.6	5.8	Bu
33.7	5.7	Mu
34.5	5.8	Sc
34.5	5.8	O
34.6	5.8	Pi
34.6	5.5	Wpi
35.5	5.8	O
35.5	5.8	Ba
35.6	5.6	Cr
35.6	5.4	Bu
35.7	5.7	Mu
37.5	5.8	O
37.6	5.4	Cr
37.6	5.2	Bu
39.5	5.9	O
42.5	5.8	O

185032

RX Lyrae

1110.6	<13.3	Ba
34.6	<13.0	M

185634

Z Lyrae

1110.6	<13.3	Ba
32.7	<13.3	Ba

190108

R Aquilae

1071.4	6.0	L
96.4	6.1	L
1108.4	6.5	L
09.6	6.4	Bu
12.6	6.3	M
16	8.0	T
18	8.1	T
18.6	6.1	B
20.6	6.9	Ba

VARIABLE STAR OBSERVATIONS September-October, 1916—Continued.

R Aquilae

J.D. 242	Est.	Obs.
1125.6	7.3	V
26.6	7.1	Ba
33.5	7.4	Ba
33.6	6.6	Bu
34	8.2	T

190529
V Lyrae

1124.6<13.0		Ba
33.6<12.3		Bu

190926
X Lyrae

1122.6	9.0	M
23.6	8.8	Ba
33.6	8.9	Pi
33.6	8.7	Ba
33.6	9.7	Bu
35.6	9.0	Pi
35.6	8.5	Wpi

190967
U Draconis

1114.6	11.8	M
27.6	10.6	M

191019
R Sagittarii

1071.4	7.9	L
76.4	8.3	Pe
79.4	8.5	Pe
81.4	8.3	Pe
96.4	8.7	Pe
98.3	8.1	L
1106.5	8.5	Pi
09.6	8.6	Bu
24.5	9.6	Ba
33.5	10.2	Ba

191033
RY Sagittarii

1066.4<	9.5	L
71.4<	9.7	L
77.4<	10.5	L
81.4<	10.0	L
96.4<	10.5	L
98.3<	10.5	L
1105.4<	10.5	L
06.6<	10.0	Pi
08.4<	10.5	L
09.3<	10.5	L
13.6<	11.0	Bu
24.5<	11.0	Ba
33.5<	12.0	Ba
33.6<	11.1	Bu

191350
TZ Cygni

1109.6	10.4	Bu
23.6	10.7	Ba
33.5	10.2	Ba

191637
U Lyrae

J.D. 242	Est.	Obs.
1120.6	9.3	Ba
22.6	10.2	M
26.6	9.3	Ba
33.6	9.5	Ba
33.6	8.6	Bu
35.6	10.5	Pi
35.6	10.4	Wpi

191808
Z Vulpeculae

1078	7.5	T
93	7.7	T
94	7.7	T
95	7.3	T
96	7.3	T
1109.3	7.1	T
10.3	7.5	T
11.3	6.9	T
16.4	7.4	T
17.3	6.8	T
21.3	7.3	T
23.3	7.3	T

192928
TY Cygni

1109.6	11.4	Bu
10.6<13.3		Ba

193311
RT Aquilae

1083.6	11.5	L
96.4	11.8	L
1109.6<12.4		Bu
24.6	13.0	Ba

193449
R Cygni

1062.4	6.4	Pe
65.4	6.7	Pe
67.4	6.7	Pe
79	8.8	T
93	7.8	T
94	7.8	T
95	7.9	T
1109	8.7	T
09.6	7.5	Bu
10	7.8	T
14	9.5	T
16.6	8.0	O
16.6	8.8	Cr
17	8.5	T
20	8.6	T
20.6	8.0	Ba
21	8.9	T
23.8	8.7	M
24.6	9.0	Hu
26.6	8.2	Ba
27	9.4	T
27.6	9.0	S
33.5	8.5	Ba
33.6	7.8	Bu

R Cygni

J.D. 242	Est.	Obs.
1134.6	9.0	Pi
34.6	9.1	Wpi
35	9.5	T
35.5	9.0	O
37.7	9.4	S

193509
RV Aquilae

1109.6<12.4		Bu
24.6	13.3	Ba
33.5	13.1	Ba

193732
TT Cygni

1102.6	7.9	L
09.6	8.2	Bu
15.6	8.3	L
23.6	7.2	Ba
24.6	7.9	Hu
33.5	7.1	Ba
36.6	9.3	M

194048
RT Cygni

1078	10.0±	T
81	8.8	L
94	10.0±	T
95	10.0±	T
1105	10.0±	T
09	10.0±	T
09.6	11.6	Bu
10	10.0±	T
14	10.0±	T
20.6	9.4	Ba
23.8	9.5	M
24.6	8.9	Hu
26.6	9.2	Ba
26.6	9.1	Le
27	9.9	T
27.6	9.3	S
33.6	8.7	Ba
34.7	8.8	Wh
35	8.7	T
35.5	9.7	O
35.6	8.8	Pi
35.6	8.9	Wpi
37	8.6	T
37.7	8.6	S

194348
TU Cygni

1109.6	11.8	Bu
20.6	12.4	Ba
23.8<	11.2	M
24.6	12.6	Hu
26.6	12.7	Ba
33.6<	12.2	Bu
34.7<	11.3	Wh
35.6<	11.7	Pi
35.6<	11.7	Wpi

194604
X Aquilae

J.D. 242	Est.	Obs.
1123.6<12.3		Nt
24.6<13.0		Ba
26.6	13.2	B
36.6<12.3		Bu
37.6	13.5	B

194632
χ Cygni

1065.4<	11.7	Pe
67.4<	12.4	Pe
1109.6<	12.0	Bu
10.6<	13.4	Ba
13.6<	12.0	Bu
27.6	11.9	M
33.6<	12.0	Bu
34.7<	11.3	Wh

195116
S Sagittae

1108.7	6.0	Mu
09.6	5.8	O
09.7	6.2	Mu
10.5	5.7	O
10.7	5.6	Mu
11.5	5.4	O
17.6	5.7	O
18.6	6.0	O
20.5	5.4	O
21.5	5.5	O
21.7	5.7	Mu
23.7	5.8	Mu
24.6	5.8	O
24.7	5.5	Mu
25.7	5.9	Mu
26.7	5.7	Mu
28.5	5.4	O
29.5	5.4	O
30.8	5.5	Mu
31.7	5.5	Mu
32.5	5.7	O
32.7	5.7	Mu
33.5	5.9	O
33.7	6.0	Mu
34.5	6.1	O
35.5	6.1	O
35.7	5.6	Mu
37.5	5.7	O
39.5	5.4	O
42.5	6.0	O

195849
Z Cygni

1094	8.6	T
95	8.2	T
1102.6	8.0	L
09	8.6	T
09.6	8.3	Bu
10	8.6	T
14	8.8	T

Z Cygni

J.D. 242	Obs.	Est.
1123	8.6	T
23.6	7.6	Ba
23.8	8.6	M
27	8.5	T
33.6	7.9	Ba
33.6	7.4	Bu
34.6	8.4	Pi
34.6	9.0	Wpi
35	8.9	T

200212
SY Aquilae

1109.6	12.4	Bu
10.6<12.2		Ba
23.6<12.4		Ba
26.6	13.4	B
33.6<12.4		Nt
33.6	12.4	Bu
37.6	13.3	B

200357
S Cygni

1123.6	12.8	Ba
33.6	12.5	Ba
33.6	12.2	Bu

200514
R Capricorni

1127.6	10.9	M

200647
SV Cygni

1108.7	9.1	Mu
23.6	8.0	Ba
23.6	9.0	Mu
24.6	8.8	Hu
26.6	8.9	M
32.8	9.2	Pi
33.6	8.1	Ba

200635
RY Cygni

1094	11	±T
95	11.0	±T

200715a
S Aquilae

1067.4	11.5	L
71.4	11.1	L
77.4	11.4	L
83.6	10.8	L
96.4	10.3	L
1102.6	10.1	L
09.3	10.1	L
09.6	9.3	Bu
11.6	10.2	B
13.6	9.6	M
23.6	9.4	Ba
33.6	9.4	Ba

VARIABLE STAR OBSERVATIONS September-October, 1916—Continued.

200715b
RW Aquilae

J.D. 242	Est.	Obs.
1109.6	8.9	Bu
11.6	9.2	B
13.6	9.4	M
23.6	9.0	Ba
33.6	9.0	Ba

200747
RX Cygni

1108.7	8.0	Mu
23.6	7.8	Mu

200812
RU Aquilae

1009.6	11.4	B
23.6	12.5	Ba
33.6	12.6	Ba

200906
Z Aquilae

1109.6	10.0	B
18.6	10.9	B
23.6	11.2	Ba
33.6	11.9	Ba

200916
R Sagittae

1111.6	9.1	B
13.6	8.8	M
17	8.8	T
23	8.9	T
23.6	8.8	Ba
33.6	9.4	Ba
34	9.5	T
35	9.5	T
37	9.4	T

200938
RS Cygni

1095	8.9	T
1102.6	9.0	L
14.6	8.8	M
23.6	8.0	Ba
34.6	9.0	Pi
34.6	9.0	Wpi
35.6	8.0	Ba

201008
R Delphini

1110.6	<12.8	Ba
23.6	<12.5	Ba
24.6	<11.3	Wh
26.6	13.2	B
34.6	<10.8	Pi
35.6	13.5	Ba
37.6	12.7	B

201521
RT Capricorni

1083.4	6.6	L
96.4	6.7	L
1109.4	6.7	L
24.5	6.6	Ba

RT Capricorni

J.D. 242	Est.	Obs.
1127.6	7.5	M
32.7	7.7	Pi
33.5	7.0	Ba

201130
SX Cygni

1110.6	11.1	Ba
14.6	11.6	M
23.6	12.0	Ba
35.6	12.0	Ba

201647
U Cygni

1084	<10.0	T
1102.6	11.3	L
09	11.5	T
09.6	10.6	Bu
10.6	10.6	Pi
13.6	10.6	Bu
23.6	9.0	Ba
26.6	10.4	M
27	11.2	T
32.8	10.0	Pi
35	9.7	T
35.6	8.6	Ba
37.7	<9.8	S

202539
RW Cygni

1113.6	8.0	Bu
14.6	8.4	M
15.6	8.5	L
23.6	8.0	Ba

202817
Z Delphini

1113.6	11.7	Bu
23.6	12.1	Ba
25.6	<11.7	V
32.6	<11.2	M
33.6	<12.0	Nt
34.6	<12.4	Bu

202946
SZ Cygni

1077.4	9.9	L
81.6	9.1	L
1102.6	9.5	L
10.5	8.7	Ba
11.6	8.8	Le
17.6	9.5	Le
20.5	9.5	Ba
23.6	9.5	Ba
24.5	9.0	Ba
26.5	8.6	Ba
32.5	9.3	Ba
33.5	9.5	Ba
34.7	9.7	Ba
36.6	9.6	M
38.7	9.6	Le

SZ Cygni

J.D. 242	Est.	Obs.
1139.7	8.9	Le
40.7	8.7	Le
41.7	8.7	Le
42.7	8.9	Le
43.7	9.0	Le

202954
ST Cygni

1113.6	10.0	Bu
21.6	9.8	Bu
23.6	10.4	Ba
32.6	9.6	Hu
34.6	9.9	Pi
34.6	9.6	Wpi

203226
V Vulpeculae

1078	9.1	T
93	9.0	T
94	9.0	T
95	9.0	T
96	8.9	T
1109.3	8.6	T
10.4	8.4	T
11.4	8.6	Ba
16.4	8.6	T
17.3	8.6	T
21.3	8.5	T
23.3	8.6	T
23.6	8.6	Ba
27.6	8.6	M
39.6	8.8	O

203611
Y Delphini

1110.6	<13.0	Ba
23.7	12.3	Ba
26.6	13.5	B
37.6	13.3	B

203816
S Delphini

1130.6	9.8	M

203847
V Cygni

1095	8.6	T
96	8.2	T
1113.6	<12.4	Bu
23.7	10.6	Ba
23.8	11.0	M

204016
T Delphini

1109.6	11.2	B
13.6	11.5	Bu
23.7	12.1	Ba

204318
V Delphini

J.D. 242	Obs.	Est.
1094	<11.5	T
1110.6	<12.8	Ba
13.6	<12.0	Bu
26.6	<13.0	B
33.6	<12.0	Bu
37.6	<12.8	B

204405
T Aquarii

1120.6	9.9	B
24.5	9.0	Ba
26.6	9.0	Nt
27.6	9.0	M
32.6	8.4	Ba
32.7	9.9	Pi
37.6	7.9	Hu

204846
RZ Cygni

1132.7	13.2	Ba
33.6	<12.0	Bu
36.6	<10.6	M

205017
X Delphini

1124.6	13.7	Ba
26.6	13.2	B
26.6	12.9	Nt
37.6	13.5	B

205923
R Vulpeculae

1123.7	7.5	Ba
27.6	8.6	M
39.5	9.1	O

210116
RS Capricorni

1109.3	8.6	L
10.6	8.4	Pi
10.6	8.4	Wpi
23.7	8.6	Mu
24.5	7.8	Ba
26.6	8.4	M
30.7	8.5	Mu
32.7	8.5	Pi
33.5	7.9	Ba

210129
TW Cygni

1109.6	12.2	Bu
26.6	12.5	Ba

210868
T Cephei

1083.6	9.1	L
1109.6	8.7	Bu
10.5	8.8	O
20.5	8.6	O
24.6	7.5	Ba
28.5	8.0	O
28.6	7.8	M

T Cephei

J.D. 242	Est.	Obs.
33.6	8.0	Bu
34.5	7.9	S
35.5	8.2	O
37.6	8.0	Cr
39.5	8.0	O

211614
X Pegasi

1113.6	10.4	Bu
23.7	9.8	Ba
29.5	9.3	O
32.5	9.4	O
35.5	9.4	O

211615
T Capricorni

1124.6	13.0	Ba
32.7	<11.8	Pi
33.5	12.9	Ba

213044
W Cygni

1171.4	5.6	L
77.4	5.7	L
81.6	5.9	L
83.6	5.8	L
89.4	5.7	L
92.4	5.9	L
96.3	5.8	L
98.4	5.8	L
1102.6	6.0	L
05.3	6.0	L
08.4	6.2	L
09.3	6.1	L
13.6	6.4	Bu
15.3	6.0	L
21.3	6.1	L

213678
S Cephei

1113.6	11.8	Bu
24.6	11.4	Ba
29.6	11.8	M
34.6	<10.2	S

213753
RU Cygni

1113.6	7.8	M
13.6	7.6	Bu
26.6	7.9	Ba

213843
SS Cygni

1071.4	9.4	L
77.4	10.9	L
78.4	11.4±	T
81.6	11.7	L
83.6	11.5	L
89.4	<10.0	L
92.4	10.5	L
95.4	11.4±	T

VARIABLE STAR OBSERVATIONS September-October, 1916—Continued.

SS Cygni			SS Cygni			SS Cygni			RV Cygni			225914 RW Pegasi		
J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Obs.	Est.
96.4	11.4±	T	1119.6	11.0	Cr	1132.8	9.7	Pi	1132.8	7.9	Pi	1109.6	10.0	Bu
96.3	10.0	L	19.6	11.7	Bu	33.3	9.0	T	35	8.0	T	20.6	10.5	B
98.4	10.3	T	20.3	11.3	T	33.5	9.4	Ba				23.7	10.6	Mu
98.4	8.3	L	20.5	<10.9	O	33.5	9.6	O	214024 RR Pegasi			24.6	10.6	Ba
99.4	8.2	T	20.5	11.2	Ba	33.5	9.0	Pi				25.6	10.9	V
1100.4	8.4	T	20.6	11.5	B	33.6	9.2	Nt	1124.6	<13.2	Ba	30·6	11.0	M
00.6	8.6	L	20.6	11.1	Cr	33.6	9.4	Cr	29.5	<11.2	O	30.7	10.5	Mu
02.3	8.1	L	20.6	11.8	Bu	33.6	9.5	M	32.6	<12.6	Pi	32.6	11.4	Pi
02.6	8.1	L	21.3	11,3	V	33.6	9.5	Sc	37.6	<13.5	B			
03.4	8.3	T	21,3	11.3	T	33.6	9.4	Bu						
05.3	8.2	L	21.6	11.4	B	33.7	10.2	Bu	215605 V Pegasi			230110 R Pegasi		
06.5	8.5	Pi	21.6	11.4	Cr	33.4	9.2	T						
07.3	8.6	T	21.6	11.7	Bu	34.5	8.9	O	1121.5	<10.6	O	1074.4	<11.6	Pe
08.4	8.3	L	22.6	11.2	M	34.6	9.3	M	24.6	<13.0	Ba	74.6	12.7	Pe
08.7	8.6	Mu	22.6	11.6	Bu	34.6	9.0	Pi	27.6	13.8	B	79.4	12.7	Pe
09.3	8.3	L	23.3	11.3	T	34.6	9.5	Cr				81.4	12.5	Pe
09.3	8.6	T	23.5	11.4	Pi	34.6	8.7	Wpi	215934 RT Pegasi			97.4	12.4	Pe
09.5	8.6	Nt	23.6	11.5	Cr	34.6	9.4	Bu				98.4	12.4	Pe
09.5	8.6	Sc	23.6	11.5	Nt	34.7	9.2	Ba	1124.6	11.0	Ba	1124.6	12.4	Ba
09.6	8.7	O	23.6	11.3	B	35.3	9.1	T	25.6	<11.3	V	26.6	12.2	Nt
09.6	8.6	Bu	23.6	11.4	Ba	35.5	8.8	O				32.6	12.5	Pi
09.6	9.0	B	23.7	11.1	Mu	35.5	9.2	Ba	220412 T Pegasi			32.6	11.8	Ba
09.6	8.4	Cr	23.8	11.4	M	35.6	8.9	Pi				32.7	<11.3	Wh
10.3	8.9	T	24.5	11.4	Ba	35.6	9.1	Cr	1126.6	13.5	B			
10.5	8.8	O	24.6	11.6	Hu	35.6	8.7	Wpi	32.6	<11.3	Ba			
10.5	8.8	Ba	24.6	11.5	Cr	35.6	8.8	Bu	220613 Y Pegasi			230759 V Cassiop		
10.6	9.2	B	24.6	11.7	Bu	35.6	9.3	B						
10.6	8.8	Bu	25.6	11.7	Cr	36.6	9.6	M	1125.6	10.4	V	1071.4	9.3	Pe
10.6	8.5	Cr	25.6	<11.3	V	36.6	9.0	Cr	26.6	10.3	B	74.4	9.8	Pe
10.7	8.5	Mu	25.7	11.0	Ly	37.3	10.1	T	29.5	11.1	O	76.4	9.7	Pe
10.8	8.7	Ly	26.5	11.6	Ba	37.5	9.4	O	32.6	11.0	M	79.4	9.7	Pe
11.3	9.1	T	26.6	11.5	B	37.5	9.2	Cr	32.6	11.1	Pi	81.4	9.8	Pe
11.4	9.0	T	26.6	12.0	Cr	37.6	9.8	M	32.6	10.7	Ba	97.4	11.1	Pe
11.5	8.7	O	26.6	11.5	Nt	37.6	9.8	Cr	35.5	11.0	O	1109.6	11.6	Bu
11.6	9.1	M	27.6	11.4	Nt	37.6	9.9	Hu	39.5	11.2	O	16.6	11.1	B
11.6	9.0	B	27.6	11.9	Cr	37.6	9.4	Bu				24.6	12.0	Ba
11.6	8.8	Cr	27.6	10.8	M	37.6	9.8	B	220714 RS Pegasi			28.5	<11.2	Pi
11.6	8.7	Sc	27.6	11.8	B	37.7	9.8	S				37.6	<11.2	M
11.6	9.2	Le	27.6	11.5	Bu	37.7	9.8	Bu	1125.6	<11.3	V	37.6	12.0	Hu
12.6	9.5	M	28.3	11.3	T	38.6	10.0	M	26.6	12.3	B	38.7	<11.0	Wh
12.7	8.8	Ly	28.6	10.7	M	38.7	10.1	Le	32.6	<12.1	M			
13.6	9.4	Bu	28.6	11.5	Cr	39.5	10.4	O	32.6	<12.5	Pi			
13.6	9,7	M	29.6	10.5	M	39.7	10.4	Le	32.6	<13.0	Ba	231425 W Pegasi		
14.3	10.1	T	29.6	11.6	B	40.7	10.4	Le	222439 S Lacertae					
14.6	9.8	M	29.6	11.5	Cr	41.7	11.1	Le				1109.6	10.8	Bu
15.3	9.8	L	29.6	11.5	Bu	42.7	11.2	Le	1111.5	<10.4	O	24.6	10.7	Ba
15.7	9.1	Ly	30.3	11.3	T	43.7	11.2	Le	23.6	12.8	B	25.6	10.9	V
16.3	11.3	T	30.6	10.3	M				24.6	12.7	Ba	30.6	10.9	M
16.6	10.9	O	30.6	11.6	Cr	213937 RV Cygni			27.6	12.8	B	32.6	10.2	Hu
16.6	10.7	B	30.6	11.4	Bu									
16.6	10.8	Cr	30.7	11.0	Mu	1093	8.0	T	223841 R Lacertae					
16.6	10.5	Bu	31.3	11.4	T	95	7.7	T				231508 S Pegasi		
16.7	10.5	M	32.3	10.5	T	1102.6	6.5	L	1133.6	9.6	M			
17.3	11.3	T	32.5	9.8	Ba	05	7.8	T	37.6	9.3	M	1074.4	9.6	Pe
17.6	11.0	O	32.5	10.1	O	09	8.6	T				76.4	9.7	Pe
17.6	10.6	O	32.6	9.8	Wh	10	7.8	T	*225120* S Aquarii			79.4	9.8	Pe
17.6	11.1	Bu	32.6	10.0	M	13.6	7.7	M				81.4	9.7	Pe
18.6	10.7	B	32.6	10.2	B	14	8.0	T	1125.6	8.5	Ba	96.4	10.1	Pe
18.6	10,8	Cr	32.6	9.9	Cr	24.6	6.8	Ba	29.6	8.5	M	97.4	11.3	Pe
18.6	11.4	Bu	32.6	10.1	Bu	24.6	7.9	Hu	32.7	9.0	Pi	98.4	11.4	Pe
						27	8.0	T	33.5	8.7	Ba	1132.6	11.9	Ba

VARIABLE STAR OBSERVATIONS September-October, 1916—Continued.

233335 ST Androm.			*233815* R Aquarii			*235209* V Ceti			235525 Z Pegasi			235939 SV Androm.		
J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.	J.D. 242	Est.	Obs.
1109.6	9.3	O	1081.4	8.3	Pe	1124.7	10.5	Ba	1111.5	10.6	O	1109.6	11.3	Bu
09.6	9.0	Bu	98.4	6.5	Pe	32.6	11.2	Pi	24.7	10.5	Ba	18.6	11.8	B
15.7	9.5	Ly	1124.7	5.9	Ba	37.6	10.3	M	28.7	11.1	V	24.7	11.9	Ba
18.6	9.1	B	29.6	6.2	M				30.6	10.5	M	32.6	12.2	Pi
24.6	9.3	Ba	32.7	6.5	Pi	235350 R Cassiop.			32.5	10.5	O	34.6	12.3	Hu
25.6	9.3	Hu							32.6	10.7	Pi			
27.6	10.0	S	233956 Z Cassiop.			1109.6 < 12.4		Bu	35.5	10.4	O			
28.5	9.5	O				23.6	12.6	B	39.5	10.5	O			
29.6	9.5	M	1109.6	11.4	Bu	27.6	10.6	M						
32.5	10.0	Pi	24.7	11.2	Ba	32.6	12.5	Ba						
35.5	9.6	O	37.6	11.7	M	37.6	12.0	B						

No. of observations 1580; No. of stars observed 233; No. of observers 20.

The fact that the sum total of observations this past year does not equal that of the past two years is entirely due to the fact that of late we have endeavored to seek new and difficult fields, and thus extend the scope of the work rather than try for a greater number of observations of the better observed variables. We have also discontinued the frequent observations of many variables.

The Association again renews its thanks to Professor E. C. Pickering for his continuing interest in our organization, and to Professor H. C. Wilson, Editor of POPULAR ASTRONOMY for promoting our interest by the publication of the reports. We also wish to express our obligation to Mr. Leon Campbell of the Harvard College Observatory staff for his very active interest in the welfare of the Association, and for the ever ready assistance he offers those of us who seek his aid. Mr. Campbell's lists of magnitudes sent out to members each month are of great value, and increase the efficiency of the service.

During the past year 291 Variable stars of long period have been observed, and the Secretary has distributed over five hundred blue prints to members.

In conclusion the secretary wishes to thank the members of the Association for their hearty coöperation and support, which has resulted in a highly prosperous year and promoted the interest of an organization we can well be proud of and which it is a pleasure to serve.

The following members contributed to this month's report:—Messrs. Bancroft, Bouton, Burbeck, Crane, Eaton, Gregory, Hunter, Lacchini, Leonard, Lindsley, McAteer, Mundt, Nolte, Olcott, D. B. Pickering, S. W. Pickering, Schulmaier, Vrooman, Whitehorn, Yendell, and Miss Swartz.

WILLIAM TYLER OLCOTT,
Corresponding Sec'y.

Norwich, Conn.
Oct. 10, 1916.

ANNUAL REPORT OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS FOR THE YEAR ENDING OCT. 10, 1916.

RECORD OF OBSERVATIONS

	Baldwin (Bl)	Bancroft (Ba)	Bouton (B)	Burbeck (Bu)	Crane (Cr)	Eaton (E)	Gray (G)	Gregory (Gr)	Hoge (Ho)	Hunter (Hu)	Lacchini (L)	Leonard (Le)	Lindsley (Ly)	Miss Ludeke (Lu)	Mach (Ma)	McAteer (M)	Mundt (Mu)	Nolte (Nt)	Olcott (O)	de Perrot (Pe)	D. B. Pickering (Pi)	S. W. Pickering (Wpi)	Richter (R)	Schulmaier (Sc)	Spinney (Sp)	Miss Swartz (S)	Vrooman (V)	Whitehorn (Wh)	Yendell (Y)	Miss Young (Y)	Additional Obs.	Total number of Observations	Number of stars observed	Number of observers
Nov.		248	41	40	15	15	16		20	36	39		31		45	106	24	23	100		73		122		25	9	15			18	7	1068	178	25
Dec.		157	33	39	3	21			27	40	47		59		61	64	39	46	62		100		81		29	5				38	15	966	179	21
Jan.		30	59	42	16	25	8		20	30	16		36		21	38	24	33	49		11		32			10	5			6	3	514	134	21
Feb.		62	14	14	20	47			8	20	49		17		9	38	14	6	40		32		46		6	12	17			17		488	127	20
Mar.			43	41		38			17	10	56		9		1	43	5	31			46		54			14	11			12		431	121	16
Apr.		79	20	41		35			4		40				2	68	21	21	53		66		12		27	13	18			16		536	153	17
May		228	8	68	8	82			18		28				4	59	34	17	63		41		40				10	1		29		738	175	18
June	14	282	48	30	18	18	11		6	16	49			14	12	145	43		66		72	4	35		17		45	8		30		983	188	22
July		352	46	2	25	31		3		9	59			23	30	148	64	21	65		52	23	84	10	49	32	40	11	34			1213	196	23
Aug.		121	28		13	90	31	7			78	67		37	52	113	119		25	39	32	17	77	14			49	14	28			1051	170	21
Sept.	41	482	119	64	24	42		6		9	78	57			65	139	53	52	36	104	55	14	66	20	15	21	50	23	49			1684	196	25
Oct.		362	97	189	51			5		26	93	16	45			170	72	23	153		101	24		5		19	20	21	88			1580	232	20
Total	55	2403	556	570	193	444	66	21	120	196	632	140	197	74	302	1131	512	273	712	143	681	82	649	49	168	135	280	78	199	166	25	**11252**		

ANNUAL RECORD OF THE ASSOCIATION.

Year	Number of Observers	No. of stars Observed	Number of Observations	Total
1912	19	175	6180	
1913	20	200	12914	
1914	28	255	14506	
1915	29	282	14724	
1916	30	290	11252	**59576**

GENERAL NOTES.

Erratum.—Professor Barnard calls attention to the fact that in Plate XXIX in the October number of POPULAR ASTRONOMY the titles were interchanged in making up the form for the press. The upper of the two photographs was made with the 6-inch Bruce lens in 1916 and the lower with the 6-inch Willard lens in 1894.

Dr. W. Zurhellen, assistant at the Royal Observatory, Berlin, died on July 15, aged thirty-six years. It is noted in *The Observatory* that Dr. Zurhellen was one of the members of the Eclipse Expedition from the Berlin Observatory to the Crimea to observe the total eclipse of 1914, August 21. The last news which we had obtained of this expedition was that Zurhellen, being of military age, had been interned in Russia, whilst the older members of the expedition were allowed to return to Germany. After a year in Russia, Zurhellen was allowed to return to Germany; he joined the Bonn contingent, and was killed in the fighting in north France. *Science*, Sept. 29, 1916.

Professor William W. Payne, director of the Elgin Observatory, formerly professor of Mathematics and Astronomy and director of the Goodsell Observatory of Carleton College, and the founder of POPULAR ASTRONOMY, was granted the degree of Doctor of Science by Carleton College October 13, 1916, on the occasion of the celebration of the fiftieth anniversary of the founding of the college. At the same time the degree of Doctor of Science was conferred upon Professor Lucian W. Chaney, and the degree of the More Humane Letters upon Mrs. Margaret Evans Huntington and Professor Horace Goodhue. All of these persons are retired members of the Carleton College faculty.

New Observatory for the University of Arizona.—A gift of $60,000 for an observatory and 36-inch telescope has been given to the University of Arizona by a donor whose name is withheld. *Science*, Oct. 27, 1916.

NOTES FROM THE YERKES OBSERVATORY.

Mr. John E. Mellish, who has been at the Observatory for the past fifteen months as Volunteer Research Assistant, will soon leave to take charge of the well equipped private observatory at Leetonia, Ohio, of Mr. Elmer Harrald, Secretary and Manager of the Crescent Wood Working Machine Company. Mr. Mellish's duties will include the use of the telescope for visitors on certain public nights, but he will have ample opportunity for personal observation with his own telescopes, as well as with those of the observatory, and he will also have improved facilities for continuing his work in making reflecting telescopes. Leetonia is on the main line of the Pennsylvania Railroad, not far from Youngstown and Alliance, in both of which centers there are many persons interested in Astronomy. Mr. Mellish is to be congratulated on this well deserved recognition.

Mr. George S. Monk, recently of the staff of the Mount Wilson Solar Observatory, began work on October 1st as Assistant in Stellar Spectroscopy. He is enrolled at the same time for his graduate work for the Ph. D. degree in the University of Chicago, from which institution he received the Bachelor's degree in 1914.

Miss Hannah B. Steele, Assistant in the Stellar Parallax Work, is also a candidate for the Doctor's degree.

Miss Alice H. Farnsworth, B. A., Mount Holyoke, 1916, has begun her studies, chiefly with Mr. Parkhurst, for the degree of M. S. **Misses Gushee** and **Wickham,** computers in parallax work, are also candidates for the Master's degree.

Mr. Stanley H. Hughes, for the last four years in charge of the Department of Lantern Slides and Prints, left on October 1st for further study at the University of Washington. **Mr. George C. Blakslee,** who has had much experience in landscape and studio work, and who has spent his summers for some years on Lake Geneva in professional photography, will hereafter be in charge of this department.

Mr. Julius Lemkowitz, during the past year computer in the Observatory, has gone to Princeton as Observatory Assistant.

Mr. Edwin P. Hubble, Fellow in Astronomy, for the past two years in charge of the two-foot reflector, is spending the autumn and winter quarters in theoretical studies at the University of Chicago.

The summer of 1916 has been remarkable for the clearness of the sky, and at the same time nights with fine seeing have been more numerous than usual. These conditions are of course related to the drought during the summer. The gain in hours of night observation for the summer is 35 per cent over the normal. During the six months from January to June there was an accumulated gain of 68½ hours, so that the total gain over the normal for the first nine months of 1916 is 19 per cent. The figures are as follows:

HOURS OF OBSERVATION WITH 40-INCH TELESCOPE.

Month	1916	Mean for Decade	Gain 1916
July	210½	146	64½
August	210½	148½	62
September	188	157	31
Total	609	451½	157½

RAINFALL AT YERKES OBSERVATORY.

Month	1916		Mean for Decade		Gain 1916	
	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters
July	0.11	2.8	3.81	96.8	−3.70	− 94.0
August	2.48	63.0	4.72	119.9	−1.24	− 31.5
September	3.92	99.6	3.56	90.4	+0.36	+ 9.1
Total	6.51	165.4	12.09	307.1	−4.58	−116.4

The Damping of Waves and other Disturbances in Mercury.—Mr. M. H. Stillman, assistant physicist in the U. S. Bureau of Standards finds that the trembling of a Mercury surface can be partially eliminated by means of a strong magnetic field properly arranged about the containing vessel. The discussion of his experiments is given in the "Scientific Papers of the Bureau of Standards" No. 289.

Biographical Memoir of George William Hill.—A very satisfactory biographical memoir of George W. Hill was presented to the National Academy of Sciences, at its annual meeting in 1915, by Ernest W. Brown, and has been published by the Academy as a part of Biographical Memoirs Volume VIII. This should be read with interest by every astronomer, and especially by students who are looking forward to work in theoretical astronomy.

Appropriation for Astronomical Work.—At its meeting on October 11, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of $300 to Professor J. A. Parkhurst, of the Yerkes Observatory, in aid of his investigation on the determination of the photovisual scale of stellar magnitudes. *Science*, October 20, 1916.

Note on a New Double Star.—The following pair was found 1916 September17 with the 12-inch Brashear refractor of the Yerkes Observatory, by the aid of which the appended micrometrical measures (made on September 17 and 21) were secured:—

B.D. $+40^\circ$ 3309($9^m.4$), 1855.0 α 18^h 7^m $21^s.2$, $\delta + 40^\circ$ $12'.3$.

	°	″	m	m
1916.713	151.8	1.31	10.0	10.7
1916.724	153.9	1.45	9.8	10.4
1916.72	152.8	1.38	9.9	10.6

The colors of the components, which form a very neat and pretty little pair are respectively white and pale blue. The magnitude estimates of September 21 are probably the more reliable of the two sets. The powers employed in obtaining the foregoing measures were approximately 270 and 488 diameters (only the former, on the second night).

I wish to express my obligations to Professor Edwin B. Frost, Director of the Yerkes Observatory, who permitted me the use of the 12-inch telescope, and to Professor Eric Doolittle, Director of the Flower Observatory of the University of Pennsylvania, for kindly looking up this star and informing me that it is new.

FREDERICK C. LEONARD.

1338 Madison Park, Chicago, Ill.
1916 September 28.

The Stars in the Daytime.—In the *Scientific American* for September, 1916, Messrs Gustave Michaud and J. Fid. Tristán of San Josê, Costa Rica, suggests that stars might be printed on photographic plates in broad daylight if an equatorial were provided with an infra-red filter and plates sensitized with the alizarin blue, silver nitrate and ammonia process were used. The scattering of light by the atmosphere decreases rapidly as the wave length of light increases, and in the invisible infra-red is practically nil. If, instead of losing rapidly in sensitiveness from the greenish yellow down to the extreme red, the human eye were sensitive to the infra-red radiations, and only to them, many stars would shine for us in broad daylight on what would then appear to us an absolutely black sky.

Maria Mitchell Memorial Fellowship at Harvard Observatory. This Astronomical Fellowship of $500 is offered to a woman for the year beginning September 15, 1917.

A competitive examination will not be held. The candidate must present evidence of qualifications under the following heads:

1. A letter from the candidate addressed to the Secretary of the Committee, giving an account of previous educational opportunities and training, and of plans for future work.

2. College diploma or a certificate from the registrar of her college, and if she has already held a position as instructor or teacher in any college or other institution, a clear statement of the work done, together with a certificate as to the quality of work.

3. Examples of work already accomplished.
4. Testimonials as to ability and character.
5. Satisfactory evidence of thoroughly good health.

The fellowship at all times must be used for purposes of serious study, and the fellow should be as free as possible from other responsibilities.

Application for the year beginning September 15, 1917, should be made under the above heads, and must be in the hands of the Secretary of the Committee MRS. CHARLES S. HINCHMAN, 3635 Chestnut Street, Philadelphia, Pennsylvania, on or before April 1, 1917.

COMMITTEE

PROF. MARY W. WHITNEY, Director Emeritus of Vassar College Observatory, *Honorary Chairman.*
ANNIE J. CANNON, A. M. Curator of Astronomical Photographs, Harvard College Observatory, *Chairman.*
PROF. EDWARD C. PICKERING, SC. D., Director of Harvard College Observatory.
PROF. ANNE S. YOUNG, PH. D. Director of Mt. Holyoke Observatory.
PROF. JOHN C. DUNCAN, PH. D. Director of Whitin Observatory, Wellesley, Mass.
ELIZABETH R. COFFIN, A. B., Vassar College, 1870, Nantucket, Mass.
FLORENCE M. CUSHING, A. B., Vassar College, 1874, Boston.
LYDIA S. HINCHMAN, *Secretary*, 3635 Chestnut Street, Philadelphia.

Astronomical Anecdotes.—Occasionally we read some amusing astronomical anecdote which pleases us. Two such anecdotes were read recently by me, in the October number of *l'Astronomie*. It may be that they will be as amusing to some of the readers of POPULAR ASTRONOMY. Translated into English:

"My riding teacher told me the following incident: one evening he was pointing out to his wife the light shining on board of an aeroplane. 'Oh! Oh!' said suddenly Mme Robert, 'it is going to pass very near to the star that is there—ah! It passes *behind* it!' " (Contributed by M. Houdard).

"An examiner for the bachelor's degree is questioning a candidate in mathematics. He asks him: 'Do you know what Saturn has in particular?' No reply. 'You have never heard it said that Saturn has a ring?' 'No, sir.' 'Well then, behold', concludes the examiner, astounded, 'Saturn has a ring' "! (Contributed by M. Danjon.)

CHARLES NEVERS HOLMES.

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Newton, Mass.

Lowell Collection on View at Roger Williams Park Museum.—A total of 1348 people visited the Roger Williams Park Museum yesterday afternoon to see the photographs of Astronomical phenomena comprising the collection of Dr. Percival Lowell, director of the Lowell Observatory at Flagstaff, Ar.

Professor C. H. Currier of Brown University was at the museum all afternoon answering questions with regard to the 150 transparencies. The people seemed much interested in the exhibit, which was opened for the first time. It will be available to the public for several weeks. The photographs are on glass and are placed in a darkened room mounted in frames with powerful electric lamps behind them. They stand out in clear relief, delicate details being much more clearly shown than in those reproduced on paper.

The collection, probably the finest one of its kind in the world, was originally arranged for exhibition in the Boston Public Library. It has also been shown in the American Museum of Natural History in New York and at Princeton and Vassar Colleges.

From the Providence (R. I.) "Evening Bulletin" of Oct. 9, 1916.